OCTOBER 1959

Power Engineering

ATOMICS

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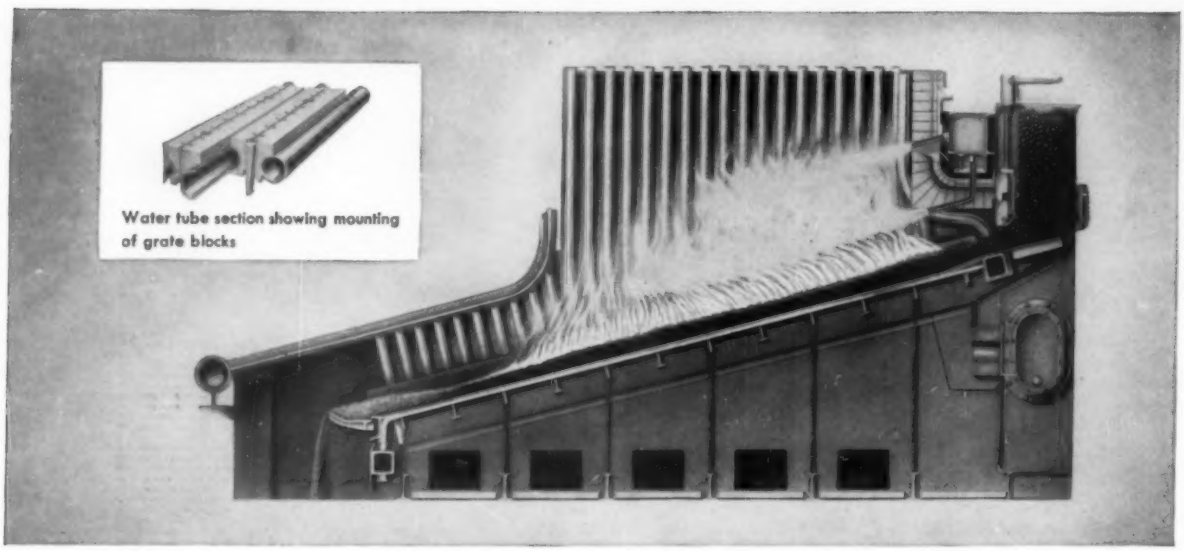
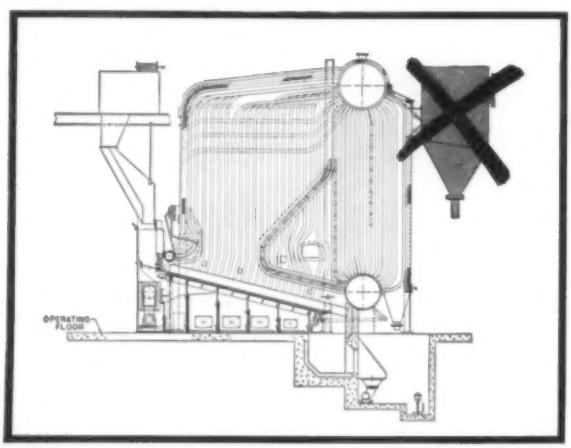
Only AE Vibra-Grate Stokers give you these 3 important benefits



Water-cooled grates. Water-cooling . . . directly connected to the boiler circulation system . . . guarantees the longest grate life available in any stoker today. Proven maintenance costs are less than one cent per ton of coal. In fact, one major installation has used less than $200.00 worth of repair parts in over four years of continuous operation!



Elimination of dust collectors and cinder return systems. Vibra-Grate burns the coal on the grate . . . dust collection and cinder return systems are not needed. You will never have to be selective in the grade of coal you burn either. Vibra-Grate feeds wet or dry fuel, high or low grade coals. It can burn gas or oil singly or in combination with coal. Overfire air assures complete combustion, giving absolute freedom from smoke at high or low ratings.

Higher efficiency. Intermittent vibrating motion of the grate feeds and moves the fuel . . . insuring even, compact distribution on the bed. A combustion-controlled electric timer determines the vibration frequency as required by fuel and steam demand. There are no light spots or holes to reduce efficiency. The grate supports form air-tight zoned sections dampered to permit accurate regulation of undergrate air.

THE AE VIBRA-GRATE offers advantages in stoker operation and efficiency that have never been available before, because it is the only stoker which combines the maintenance saving features of water-cooling and the high efficiency features of a vibrating grate and controlled zone undergrate air. Only from Vibra-Grate can you get such dramatic reductions in maintenance costs . . . as well as efficiencies that can't be equalled. Write for complete information on what Vibra-Grate stokers can do for you in terms of lower operating costs. American Engineering Company, Dept. S-101, Philadelphia 37, Pa.

AMERICAN ENGINEERING COMPANY
Wheatsheaf Lane and Sepviva Street • Philadelphia 37, Pa.

Canadian Subsidiaries: Affiliated Engineering Corporations, Ltd., Montreal, P. Q., Bawden Industries Ltd., Toronto, Ont.

For more data circle 501 on Post Card

Above: After welding together two sections of volute (one shown below) the areas adjacent to the welds are high frequency induction heated to 1950°F. prior to quenching.

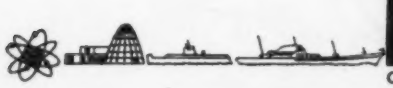
Below: Section of volute which is fabricated entirely of Stainless Steel Type 316, for handling of liquid metal at 1250°F.

Stainless Steel Volute for liquid metal...

fabricated by Pittsburgh Piping

This stainless steel volute was fabricated by Pittsburgh Piping for a leading builder of nuclear energy equipment. The job was awarded to us because we have highly specialized facilities, plus broad experience in nucleonic piping work. This experience began when we fabricated piping for the Nautilus and for the main coolant lines of the Shippingport atomic-powered central station. It has been extended and expanded through the work we have been doing for the atomic-powered submarine and surface vessels now being built, and for scores of government and industrial nuclear energy installations. Use this experience on your next nucleonic piping job. Our representative will call on request, or we will be glad to have you visit our plant.

PIONEER FABRICATOR OF HIGH PRESSURE PIPING FOR NUCLEONICS



Pittsburgh Piping AND EQUIPMENT COMPANY
158 49th STREET • PITTSBURGH 1, PA.

Canada: CANADIAN PITTSBURGH PIPING, LTD., 68 YONGE STREET—TORONTO, ONTARIO

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GRAVER
WATER
CONDITIONING
CO.

Division of
Union Tank Car Company

216 WEST 14TH STREET, NEW YO

V.J.C.-
This may be of
interest to you
H.T.S.

Inter-Organization Correspondence

TO: General Manager

FROM: Technical Director

SUBJECT: Review of Reactivator History

Approaching the 20th anniversary of the Reactivator we would like to summarize briefly its rise to the leading position among solids-contact water clarifiers and softeners. From the beginning, two basic elements were incorporated in the Reactivator design: positive sludge recirculation and mechanical sludge removal over the entire bottom area. Twenty years have confirmed the soundness of these original concepts.

By a constant effort to improve design performance, some important modifications have been made. (1) The method of inducing solids-contact was changed from air to impeller-pump to produce gentle and effective sludge recirculation. (2) The geometry of the machine was modified to get the best conditions for separation of solids from water. (3) Increased knowledge of sludge characteristics led to the redesigning of the sludge removal system.

As a result of these changes the Reactivator is able to provide: (1) solids-contact with the highest concentration of solids for the longest period of time; (2) an increase in throughput rate up to 2½-3 gpm/sq. ft., in certain cases; (3) more reliable and efficient mechanical sludge removal; (4) outstanding surge-proof characteristics.

Probably the most significant work in our program to improve the machine has been our very extensive field studies. We have had the opportunity to work with units from 8 to 125 ft. round and square on applications as widely divergent as...clarifying Arctic tundra lake water...softening and clarifying Mississippi and Colorado River waters...reducing color in Louisiana bayou water...treating hard, clear midwestern deep well supplies, and many more. The complete story of these applications is contained in our new Reactivator Bulletin WC-103C.

The sum total of our experience and knowledge has gone to make the present-day Reactivator the most versatile and reliable solids-contact unit on the market. It is gratifying to all of us to have participated in the development of such a machine.

M.L.

ML/lz

Technical Director

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NBP BPA

PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

ARE YOU PREPARING to take any of the forthcoming examinations for your professional engineer's license? If so, you can get a great deal of practical help from a new publication, Past Examinations for Professional Engineer, compiled by John D. Constance.

This is a planographed, illustrated compilation of past examinations for professional license, given between 1946 and 1959 by the New York State Board of Examiners to candidates for the written examination. Reproduction has been made with permission of the Board. This planographed collection contains a total of about 1500 questions, covering all categories of the examinations. As readers know, the categories are:

Part I — Structural Planning and Design.

Part II — Basic Engineering Sciences (hydraulics, thermodynamics, mechanics and machine design, electrical equipment).

Part III — Group A — Engineering Economics and Practice; Group B — Chemical Engineering; Group C — Civil Engineering; Group D — Electrical Engineering; Group E — Mechanical Engineering.

This collection is extremely valuable to engineers in states other than New York because most state examination boards have tried to create more uniformity in the types, quality and quantity of the questions asked. This should help in attaining licensure by endorsement, to expedite free flow of engineering talent across state lines.

The book will cost you only $2.50; in our opinion, it is well worth it. You can get it by writing directly to John D. Constance, 625 Hudson Terrace, Cliffside Park, New Jersey.

Mr. Constance, himself a professional engineer and consultant, has specialized in aiding engineers in preparing for the professional license examinations. He has had numerous articles on this subject in previous issues of POWER ENGINEERING and other magazines. He has also incorporated this information into a book, *How to Become a Professional Engineer.*

Another Associate Editor Wanted for POWER ENGINEERING

ARE YOU the man? We have another opening in the editorial staff for a mechanical or electrical engineering graduate, not over 35 years old, with at least 2 to 4 years of power engineering operating experience in utilities or industry or both. Holding of PE license would be an advantage, as would some knowledge of diesel, hydro, refrigeration, air conditioning and compressed air practices.

The man we want must have a good personality, like to travel some and investigate new developments over the country. He should be able to write, but previous *editorial* experience is not required.

If you are interested and meet these specifications, send a photograph and résumé of your experience to the Editor, POWER ENGINEERING, 308 East James Street, Barrington, Ill.

EVER HEAR of using a ferry boat as an engineering office? Well, that is exactly what Public Service Electric & Gas Co is planning to do. It is going to take the *S. S. Niagara,* which for more than 47 years ferried commuters from Weehawken to mid-Manhattan and has now been abandoned as a ferry, and use it as an office and construction headquarters at Public Service power stations in New Jersey. All the company's generating stations border on water, so the ship can be moved wherever new construction is planned.

The vessel is undergoing alterations so that the lower deck passenger areas will become clerical offices. Space in the center will be cleared to house carpenter, pipe and electrical shops and storage,

and provide space for a radiography laboratory. Topside will become the engineering offices. The vessel contains about 18,000 sq ft of usable space. It will first go into service at the Sewaren generating station, where the company plans to install an additional 340,000-kw turbine generator.

1959 EDITION of the booklet, "I Want to Know About The Electric Industry," is now available from Edison Electric Institute. Did you know, for example, that the electric industry in 1958 made the largest annual addition of generating facilities in its history, with the net installation of 14,000,000 kw of new capability? Other interesting facts:

The United States produced about 4140 kwh for every American, nearly four times the Russian per capita production of 1115 kwh. The $3.8 billion spent by electric companies for new plant and equipment represented 12.5 per cent of total 1958 expenditures for new facilities by all industry in the United States. The electric industry is adding one million new customers a year, with the total reaching 56,000,000 in 1958.

MEETINGS AHEAD: Use of coal and coal-handling equipment by medium-sized, industrial-type plants will be discussed at a conference to be held at Purdue University, Lafayette, Ind, on October 14 and 15. Details of the program have been announced by Frederick B. Morse, professor of mechanical engineering at Purdue.

The program has been planned primarily for plant managers, superintendents of power plants, superintendents of utilities, and directors of physical plants. There will be panel discussions on the following: the selection of coal; economic selection of equipment for new plants and modernization or expansion of old plants; coal-fired steam generating units — 20,000 to 125,000 lb per hr; coal-burning equipment for steam generating units — 20,000 to 125,000 lb per hr.

32nd annual meeting of the Federation of Sewage and Industrial Wastes Associations will be held October 12–15 at the Statler Hilton Hotel and Dallas Memorial Auditorium, Dallas, Texas.

Atomic Energy Commission, in coöperation with AEC contractors, will sponsor a two-day symposium for management and technical personnel on the reprocessing of nuclear fuels, in Richland, Wash., October 20–21.

AIME-ASME Joint Solid Fuels Conference will be held October 27–29 in the Netherland-Hilton Hotel, Cincinnati, Ohio. Long-range appraisal of mechanized mining will be an important aspect.

41st presentation of the American Society for Metals' National Metal Exposition and Congress will be staged November 2–6 at the International Amphitheatre and several hotels in Chicago.

American Nuclear Society will hold its winter meeting November 4–6 in Washington, D. C. at the Sheraton Park Hotel.

W. DAN SINCLAIR has joined Kaiser Engineers Division of Henry J. Kaiser Company as a power consultant. His specific assignment will include development activities in the power field, with particular emphasis upon utilities of medium size. Sinclair has a broad background of both public and private power service, and is particularly known in the industry for his achievements at Plant Crisp at Cordele, Ga, the nation's first combined gas turbine-steam turbine generating facility. He is a member of AIEE and SAME; American Public Power Association has awarded him the James D. Donovan Personal Achievement Award for his activities at Plant Crisp.

W. Dan Sinclair

Gwilym A. Price, chairman of the board of Westinghouse Electric Corp, will receive the John Fritz Medal at ASME's annual meeting at Atlantic City early in December. This is the first time in the 58-year history of the coveted award that the recipient is a man with non-engineering background.

James Staenglin, executive building superintendent of New York's Roosevelt Hotel, has been awarded an exemplary service plaque by the National Association of Power Engineers in recognition of his services as president of the Association.

Hugh H. Foreman, special engineer on the industrial sales staff of the Southern California Gas Co, has been elected president of the National Association of Power Engineers.

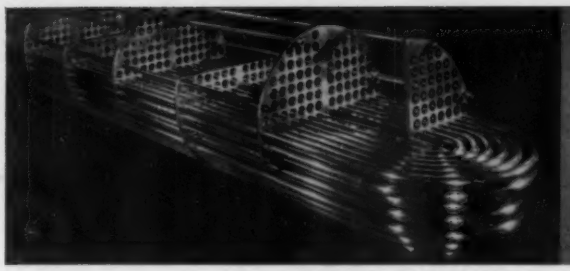
Joe B. Browder, assistant to the vice-president in charge of sales and sales manager for the Georgia Power Company, has been elected president of the Illuminating Engineering Society.

Joseph K. Pearson, formerly mechanical project engineer with Jackson & Moreland, Inc, is now with Kerr Atkinson, consulting engineer in the steam and power field, with offices in the Statler Office Building, Boston. Before joining Jackson & Moreland, Pearson was plant engineer at the Merrimack Manufacturing Co, Lowell, and Bridgewater Paper Co, Adams, Mass.

Edward H. Barry, formerly mechanical engineer with Stone & Webster Engineering Corp, also joined Kerr Atkinson on October first after a vacation in England. Barry formerly was with West Virginia Pulp and Paper Co, Cumberland, W Va, and Riley Stoker Corp, Worcester, Mass.

Carlton B. Smith, director of service for Allis-Chalmers Industries Group, died July 6 in Milwaukee. He was 63. Smith started working for Allis-Chalmers in 1914 as a machinist apprentice, became manager of the service and erection department in 1951, and director of service in 1957.

Neander Woods Wade, vice-president of Memphis Light, Gas and Water Division, died July 20. He was 60. In 1922, Mr. Wade was employed by the Board of Water Commissioners of the City of Memphis to make a study of stores inventory and cost accounting. In 1923, he was given full charge of general accounting. As assistant to the secretary from 1926 to 1935, he was in active charge of the financial affairs, accounting and administrative work of Memphis Light and Water Division, and in January, 1959 became vice-president.



CONDENSER AND HEAT EXCHANGER CLINIC

Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, New York

New tube mill equipment gives designer of heat-transfer units freer hand in meeting new trends

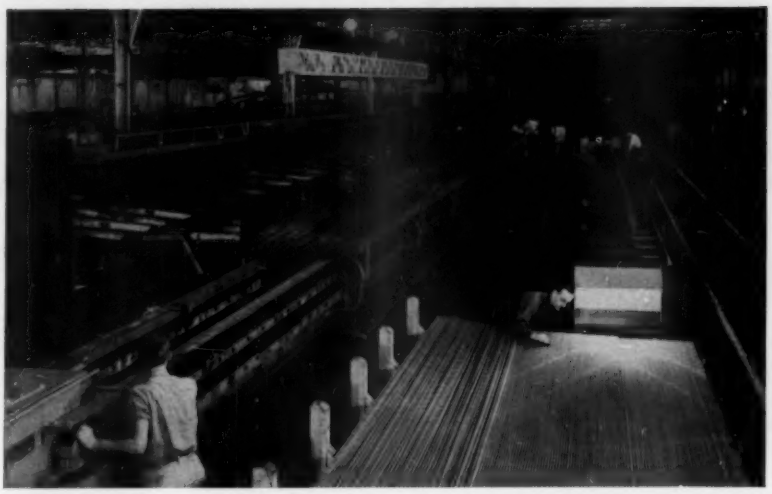
With the installation of new production and testing equipment, The American Brass Company now offers the most complete service available to users of condenser and heat exchanger tubes.

Long lengths. To gain advantages in construction, processing, or installation, designers can lengthen equipment considerably. Tubes can now be drawn up to 100 feet. Most of the longer tubes are required as U-bends, but in some instances may be shipped as straight lengths.

U-bends. Tubes from ⅜″ O.D. to 1½″ O.D. with wall thicknesses from .049″ (18BWG) to .134″ (10BWG) can be bent on a radius of from 1¼ times the tube O.D. to 30″.

Dual Gage. Where high temperatures and pressures are involved, it may be desirable to thicken the tube wall in the area of short-radius bends on U-bend tubes. Walls are thickened one Stubs' Gage No. to compensate for thinning of metal in the bending.

Thickened Tube Ends. To compensate for thinning by rolling or by impingement corrosion caused by high velocities, tubes may be supplied with the wall thickened at one end one or more Stubs' Gage Nos. The extra thickness may be on the outside or inside of the tube as required.



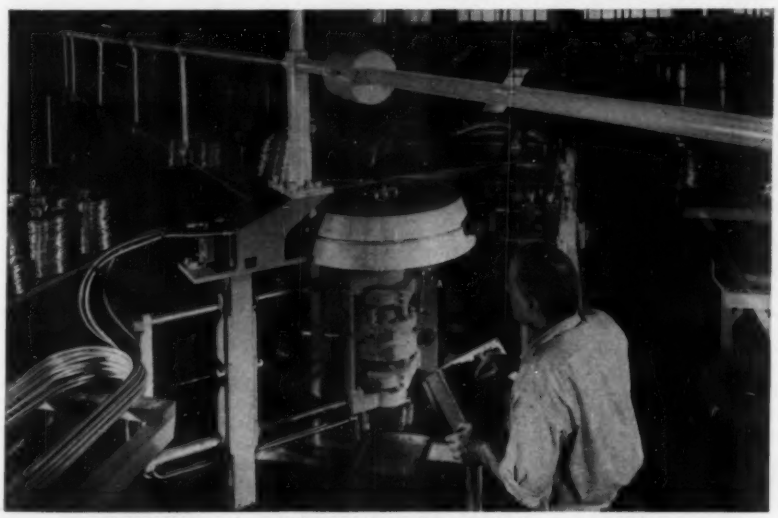
GENERAL VIEW of new American Brass Company equipment which can draw copper and copper alloy tubes in lengths up to 100 feet.

Relieving Stresses. All U-bend tubes, other than copper, are annealed at the bend area after bending, to eliminate the hazard of stress-corrosion cracking which might occur in service due to stresses that may exist as a result of the bending.

Testing. U-bends are tested hydrostatically at ASTM Specification pressures —or at ASME Code pressures up to 6000 psi on request, if the tube size will stand it. Electronic inspection with eddy-current equipment is available also, when required.

Shipping. U-bend tubes are shipped packed for ease in handling and storage.

Technical Assistance. For more detailed information on extra-long tubes, U-bend, Dual-gage, or Duplex tubes to meet special problems, address: The American Brass Company, Buffalo Division, Buffalo 5, New York. In Canada: Anaconda American Brass Limited, New Toronto, Ont. 8957 Rev.



BENDER CAN produce U-bend tubes with straight leg up to 50′ long.

ANACONDA®

TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS

Made by
The American Brass Company

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WHAT THEY TELL US

▶ **ARNO C. FIELDNER,** retired chief fuels technologist of the U. S. Bureau of Mines, writes us:

> I read the article on Underground Gasification in the May issue of POWER ENGINEERING with considererable interest, also the editorial. I think that you have done well to call attention to this problem and the importance of larger appropriations if further progress is to be made.
>
> In your article, I am not clear as to whether any of the large scale underground gasification plants in Russia now in operation are gasifying bituminous coal. I know that such plants are operating on brown coal or lignite but I am under the impression that the gasification of bituminous is still on an experimental basis. The porous nature of the brown coal beds lends itself much better to underground gasification by the bore-hole method.

All the data we have refer to lignite and sub-bituminous coal or brown coal, with the exception of the Alabama Power-Gorgas deposit, which is bituminous in a narrow seam.

▶ **READER J. M. TOTTEN,** power engineer, Stone & Webster Engineering Corp, tells us:

> In What They Tell Us, in the July issue, you ran an item concerning cavitation of hydroelectric turbine runners. I believe that some of the statements therein are actually misleading and I would suggest that your readers would appreciate their correction.
>
> The statement was made that cavitation greatly affects the efficiency of the turbine or pump. This is certainly true, but don't you think that it would be well also to point out that a decrease in efficiency is often an indication that cavitation exists and this indication may appear before noise or other symptons manifest themselves?
>
> You referred to vibration as being an effect of cavitation. Do you not believe that it would be well also to point out that vibration under certain circumstances may be a cause of cavitation?
>
> The accepted theory is that cavitation results from the collapse of vapor (not vacuum) bubbles or "implosions." This theory is sound, period! The surfaces do not have to be uneven. The surfaces can be polished to the equivalent of an optical finish and still suffer from cavitation.
>
> Among authorities, I feel sure that there is agreement that, in true cavitation, electrolytic corrosion is not a factor. Foettinger proved that electrolysis did not enter into the phenomenon, by producing cavitation in a venturi-shaped channel made of neutral glass. This was corroborated by Hunsaker's research work in which he produced cavitation of a lead plate. The lead plate was damaged by pitting, but there was *no loss in its weight.*
>
> I suggest that if Mr. Friedmann and others who are interested in this subject will read chapter 12 of "Centrifugal and Axial Pumps" by A. J. Stepanoff they will no longer confuse cavitation and electrolytic corrosion.
>
> My source of information is the above-mentioned book which contains much valuable information for anyone having to do with the application, operation and maintenance of centrifugal and axial flow pumps.

Yes, Mr. Totten certainly is right in calling attention to the fact that perhaps the electrical phenomenon that we commented on in our article may be the well-known phenomenon of electrolytic corrosion. Stepanoff is very specific on this point, as Totten says.

However, we brought this point up with both the men referred to in our published item and they know about it, but think the thing they are investigating is something different. They may, of course, be entirely wrong and it may be electrolytic corrosion, after all, that they are looking at. We will hear more from them about this.

▶ **SOME TIME AGO** we published a note about a new development of an a-c motor "which uses d-c excitation to the stator and two-phase a-c voltage to the armature" to achieve smoothly adjustable speed characteristics and power factor correction. This is the work of Prof. Paul K. Charlu, an engineer living in South India.

One of our readers, Russell B. White, who is an electrical engineer in Pennsylvania, questioned the statement "d-c excitation to the *stator* and two-phase a-c voltage to the *armature*" (rotor?). Said he:

> This is the reverse of a normal synchronous motor, as you well know, where d-c is applied to the rotor (field) and three-phase a-c is applied to the stator (armature). I presume you have some means of altering the frequency of the rotor voltage and run the motor in "step" or synchronism with the variable frequency. Am I correct in this assumption?
>
> You may be aware of the principle U. S. Electrical Motors, Inc, use. They change the speed of an alternator by mechanically adjusting a pulley ratio between the main a-c drive and the alternator. The resulting variable frequency supplies power to synchronous motors, generally several of which are attached to a single machine.

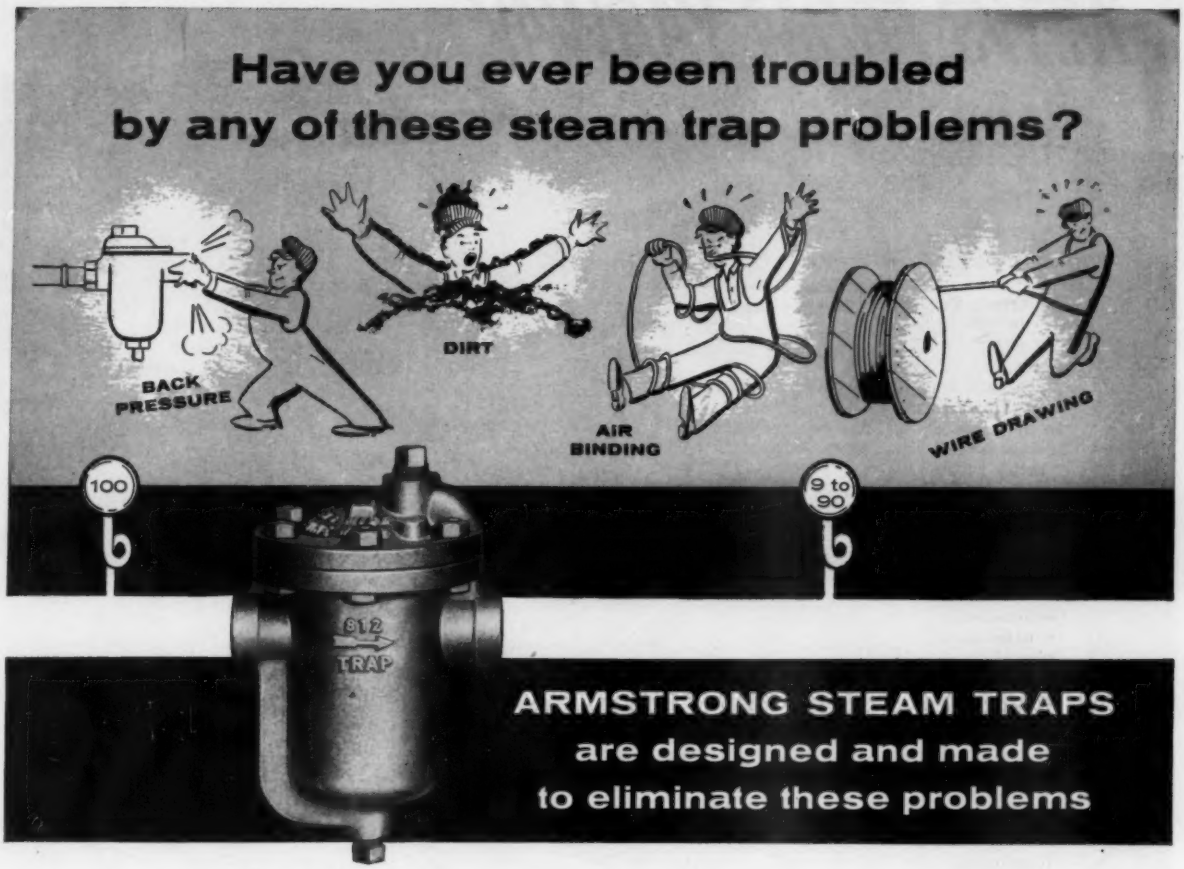
To this, Prof. Charlu replies:

> The sentence should have read as follows: D-c excitation to the stator and variable a-c voltage to the armature through synchronously revolving brushes on the armature commutator.
>
> As it is very difficult to explain fully the design features and principles of operation of the new machine without the aid of diagrams, I request you to kindly refer to AIEE paper No. 59–136, on a novel type of smoothly variable speed motor with widely adjustable power factor characteristics.
>
> With further modifications, the new machine is under the process of being patented.

▶ **GROWING DEMAND** for engineering guidance is a significant sign of the times to A. F. Bochenek, development engineer for the Bituminous Coal Institute. Bochenek writes:

> If I read the signs of the times correctly, I see a trend within the engineering profession to a private practice of consulting engineering. The strengthening of the licensing laws and the statistics on new consulting engineering firms seem to confirm this. . . . The increasing number of consulting engineering firms I believe is symptomatic of the lay bewilderment and the growing demand for engineering guidance.
>
> If this is so, then manufacturers ought to be concerned about the needs of the guides of public buying. It would be unwise not to heed the request of consulting engineers for a modification in promotional literature; for if the one who guides is uninformed about the facts deemed essential to him, he will surely lead his charges past their product.
>
> We in BCI have given a great deal of thought to the needs of consulting engineers as these needs relate to our industry. We attach great importance to the call for a revised promotional literature. Our small efforts have met with gratifying acceptance, especially among new firms which have not yet had occasion to work with coal.

Have you ever been troubled by any of these steam trap problems?



ARMSTRONG STEAM TRAPS are designed and made to eliminate these problems

BACK PRESSURE . . . Armstrong Traps operate on any back pressure—or vacuum, for that matter. As long as there is a pressure differential across the trap, it will close on steam and open for condensate. Even the high back pressure caused by blow through of one or more traps in the system will not disturb Armstrong Traps. Other than a reduction in capacity, Armstrong Traps are unaffected by back pressure.

DIRT . . . Armstrong Traps are not affected by ordinary dirt. When the trap opens condensate swirls down under the edge of the bucket and up through the discharge orifice. Dirt is kept in suspension and discharged along with the condensate. For very bad dirt conditions, Armstrong offers traps with integral strainers. These cost less than a trap plus a separate strainer.

AIR BINDING . . . Armstrong Traps cannot air bind. Air in the system passes through a vent in the top of the bucket. It collects in the top of the trap and is discharged with the condensate. There is no chance for it to stop the trap. For low pressure on-and-off units where large amounts of air accumulate while the steam is off, Armstrong offers open float and thermostatic air vent traps in a complete range of sizes.

WIRE DRAWING . . . Armstrong Traps are designed and made to resist wire drawing. The valve and seat are tough stainless steel. The valve opens and closes tightly with a fast action and is always water sealed. There is virtually no chance for grit or sediment to lodge in the valve, virtually no chance to create conditions that lead to wire drawing.

There's no need to accept any of these problems as "inevitable." Your local Armstrong Representative can show you how to end them all. Call him today or write direct.

860 Series for low pressure heating service.

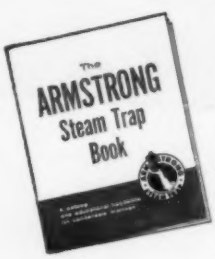
800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.



The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

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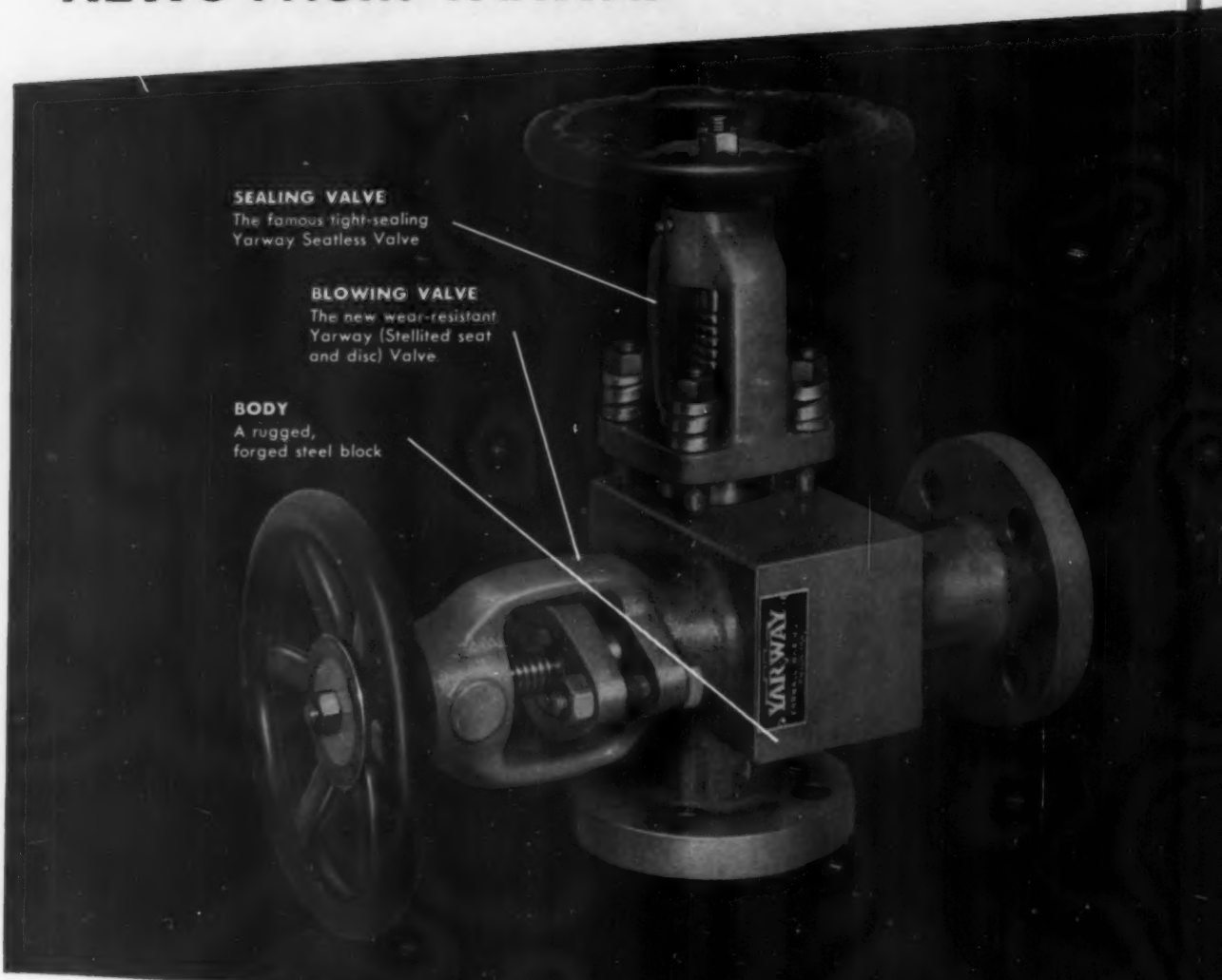
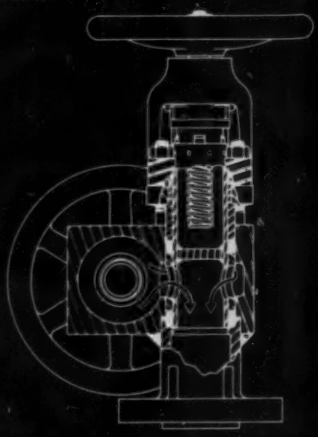
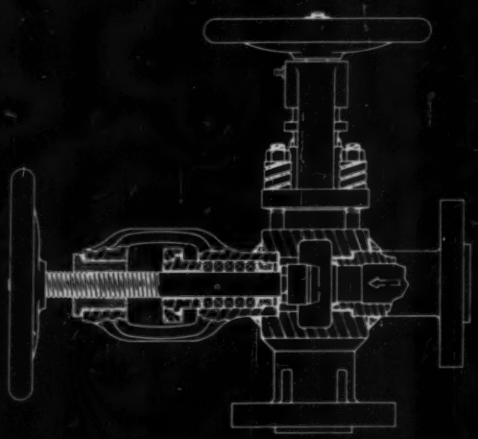


NOW! A NEW YARWAY BLOW-OFF VALVE FOR...



Cross-section showing seatless sealing valve in open position. Flanged ends shown, welding ends also available.



Cross-section of medium pressure Unit Tandem Valve showing hard-seat blowing valve in open position.

UNIT TANDEM MEDIUM-PRESSURE BOILERS

There's a new star in the Yarway Blow-Off Valve line.

For years rugged Yarway Unit Tandem Blow-Off Valves have been standard equipment on most high pressure boilers. In fact, more than 80% of high pressure plants use Yarways.

Now a *new design* Unit Tandem is offered for *medium pressure boilers to 665 WSP.* Streamlined, lighter in weight, easy to operate, tight sealing and long wearing —this valve brings premium quality Yarway Unit Tandem dependability to the medium pressure field— *at a competitive price!*

Important features, like the nitralloy plunger in the sealing valve and integral stellite seat and disc in the blowing valve, make this your best buy for blow-off service.

Order Yarway Unit Tandems for your present boilers— or specify them on new boilers.

For full details write for Yarway Bulletin B-435, Supplement A.

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Pfizer

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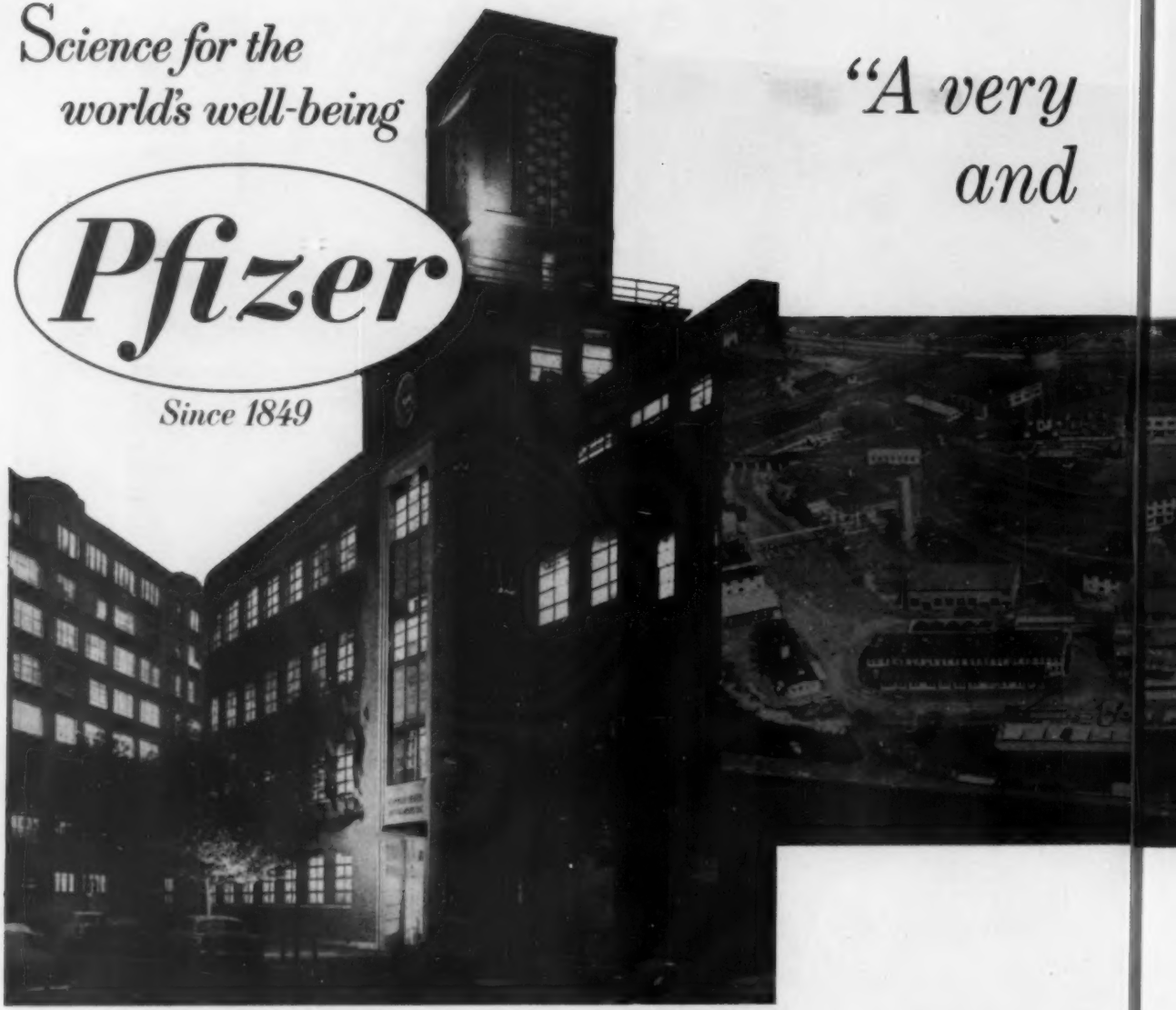

Pfizer headquarters: executive offices and research laboratories in Brooklyn, New York. In the associated production plant, a modern Combustion VU-50 Boiler has been meeting essential heat and processing requirements during the past four years by producing 140,000 lbs of steam per hour.

Pfizer's Vigo Plant relies on four Combustion VM Boilers fired by C-E Spreader Stokers for economical heating and processing. Well suited to fill local needs, these units are each rated at 30,000 lbs of steam per hour at an operating pressure of 150 psi. In various Pfizer plants, nine C-E units have a total steam production capability of 740,000 lbs of steam per hour.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

satisfactory dependable Boiler"

says C. V. Reichelt, Director of Engineering, Chas. Pfizer & Co., Inc.

At this large Pfizer fermentation and organic synthesis plant in Groton, Conn., a new C-E Vertical-Unit Boiler, Type VU-50X, has just been placed on the line. Rated at 165,000 lbs of steam per hour — a new high for Pfizer — it joins three other oil fired C-E boilers, two VU-40 units and one VU-50 unit, already in service at the plant. Each is rated at 115,000 lbs/hr.

When Chas. Pfizer & Co., Inc., recently put into service a new C-E Vertical-Unit Boiler in their Groton, Conn., fermentation and organic synthesis plant, they were capitalizing on long experience. Eight previous C-E units, three of them at Groton, had been producing steam efficiently in Pfizer plants since 1948.

Mr. C. V. Reichelt, Director of Engineering, describes Pfizer's experience with its latest C-E unit as follows: *"The new 165,000 lb/hr boiler . . . is proving to be a very satisfactory and dependable unit. Particular commendation is made of the refinements with regard to air pre-heater and fly ash arrestors which Combustion Engineering included in their design. Special mention is also made of the fine job that was done in getting the boiler on the line on time in spite of a tight schedule for fabrication and erection. This boiler is the fourth and largest C-E boiler installed at our Groton facilities."*

With three other C-E Boilers at Groton, this unit is now producing steam for power and process in the production of the well-known Pfizer antibiotics such as Terramycin as well as for a wide range of pharmaceuticals and chemical and agricultural products.

Pfizer's experience with C-E boilers extends beyond Groton, too. At Terre Haute, Indiana, the company's Vigo Plant uses four Combustion boilers fired by C-E Spreader Stokers; and at the Brooklyn Plant, the company's original "shop", dating back to 1849, another C-E Boiler is entering its fourth year of service.

Today, in more than 100 countries around the world, Pfizer "Science for the world's well-being" contributes to the advance of medicine, agriculture and industry. Combustion Engineering is proud to have a share in this march of scientific progress.

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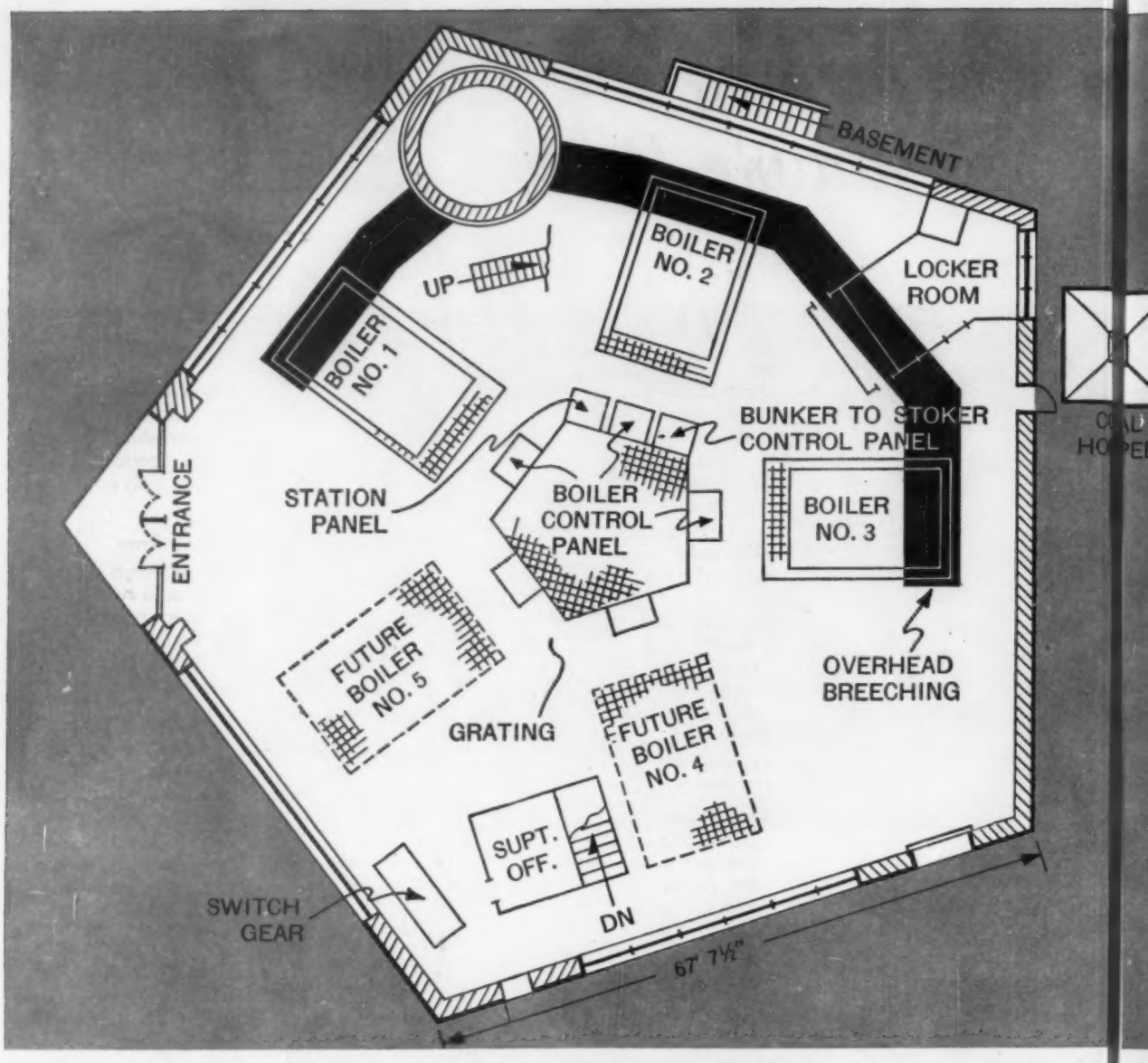
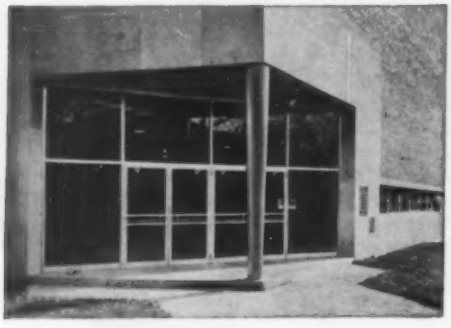
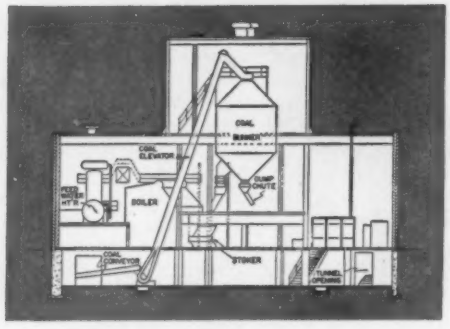
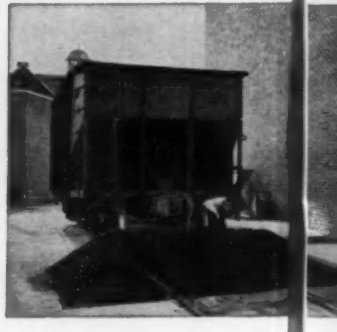




Entrance to unusual "little Pentagon" structure. This shape gives maximum space utilization and allows one-man central control of all boilers. Construction provides comfortably for three 31,000 lb/hr boilers and allows for two similar units in the future, within 7,000 sq. ft.



Elevation shows how coal moves from incoming conveyor by 25 ton/hr. Stephens-Adamson Redler elevator to overhead bunker (capacity 125 tons). Coal feeds from here to scales, then directly into stokers. Bunker and scales by Beaumont Birch Co.



Coal is brought in by rail and unloaded into track hopper. From here, a Stephens-Adamson conveyor carries the coal into the plant and internal coal handling system.

Hospital cures fuel ills with "little Pentagon"

Richmond State Hospital burns coal for economy and availability in modern pentagonal power plant

After a power system failure at the Richmond State Hospital, Richmond, Ind., the administration conducted an engineering survey of its steam-generating operation. Over-age equipment indicated the need for entirely new facilities. The shape of the boiler room site prompted the unconventional pentagonal installation for best possible adaptation of space to present and future needs. *Economy* and *availability* dictated the choice of coal as the fuel.

Today a new power plant—designed by Fleck, Quebe and Reid, Indianapolis, with F. B. Morse, of Purdue University—burns coal in a completely modern, automatic operation. The outstanding features of this compact installation are its high combustion efficiency, minimum manpower requirements and continuing ease of maintenance.

Coal is lowest cost fuel

Today, *when the annual cost of fuel often equals the original cost of the boilers,* you should know that bituminous coal is the lowest cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% *more* steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you with the efficiency and economy of coal.

Technical advisory service

To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to address below or send coupon. Ask also for case histories booklet, complete with data sheets. You'll find them informative.

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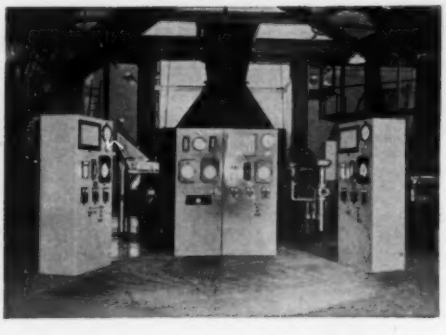

Shown are three Henry Vogt boilers, fed by Laclede chain grate stokers, with individual control panels. Controls are pneumatic type, by Copes Vulcan. From boilers, ashes are moved pneumatically by United Conveyor Ash handling system to silo for disposal.

SEND COUPON FOR NEW BCI PUBLICATIONS. Guide Specifications, with complete equipment criteria and boiler room plans:

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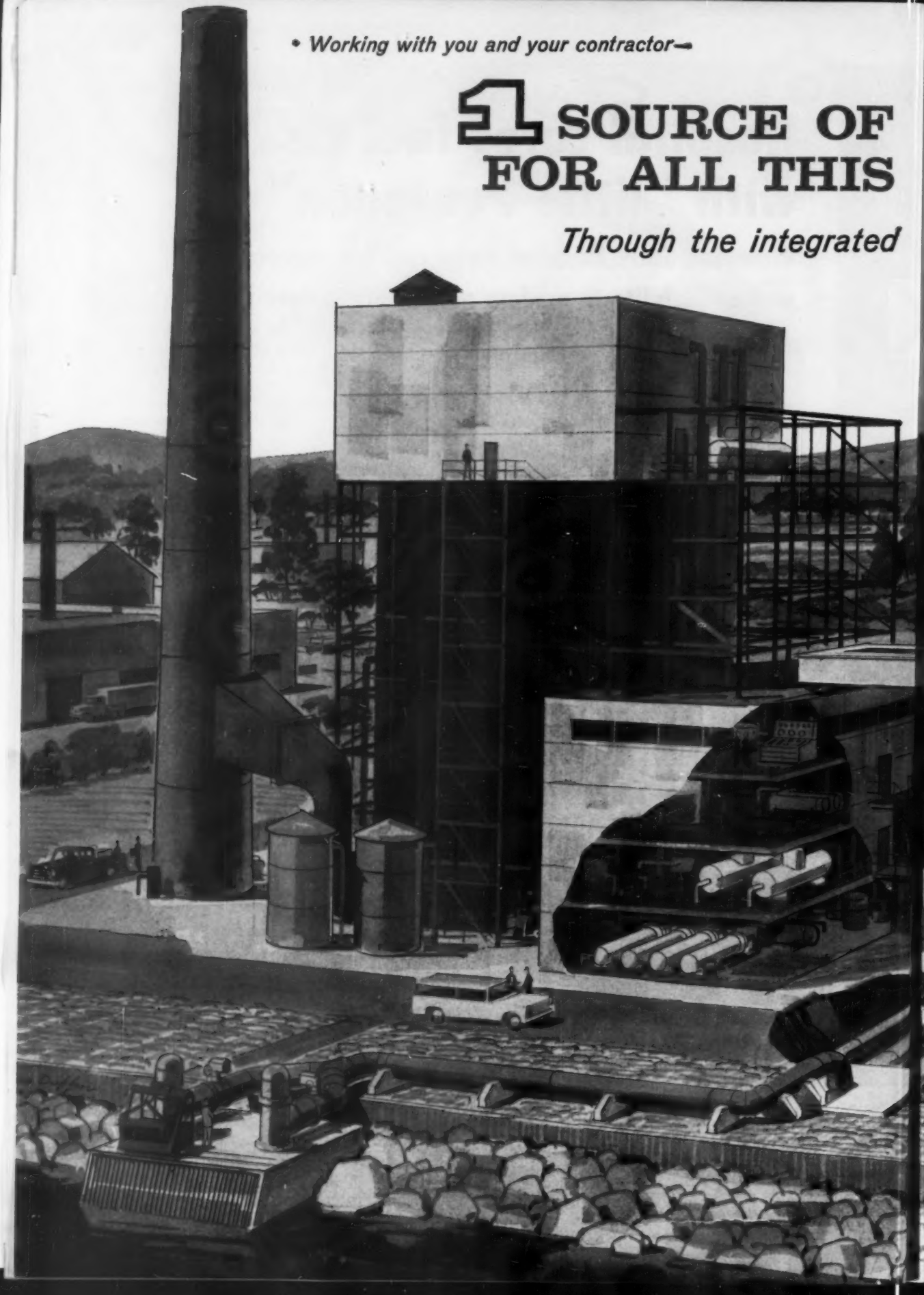

SUPPLY 1 RESPONSIBILITY POWER PLANT EQUIPMENT

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The problem of coordinating all the purchases and delivery of specialized equipment for steam plants can be greatly simplified—when it is packaged as a single responsibility with Yuba.

The advantages to you, your consultants and your contractor are many. They can easily add up to major savings in time, money and trouble. The experienced Yuba organization is geared to deliver a fully integrated service every step of the way: through equipment design, engineering, manufacturing, installation and erection.

Operating nationwide, the divisions and manufacturing plants of Yuba serving the power industry are ideally equipped and located to maintain the highest product quality standards and meet the most demanding completion dates—economically.

Call in your Yuba man. Discuss your plans and problems with him. See how your job can be made easier with his and Yuba's help.

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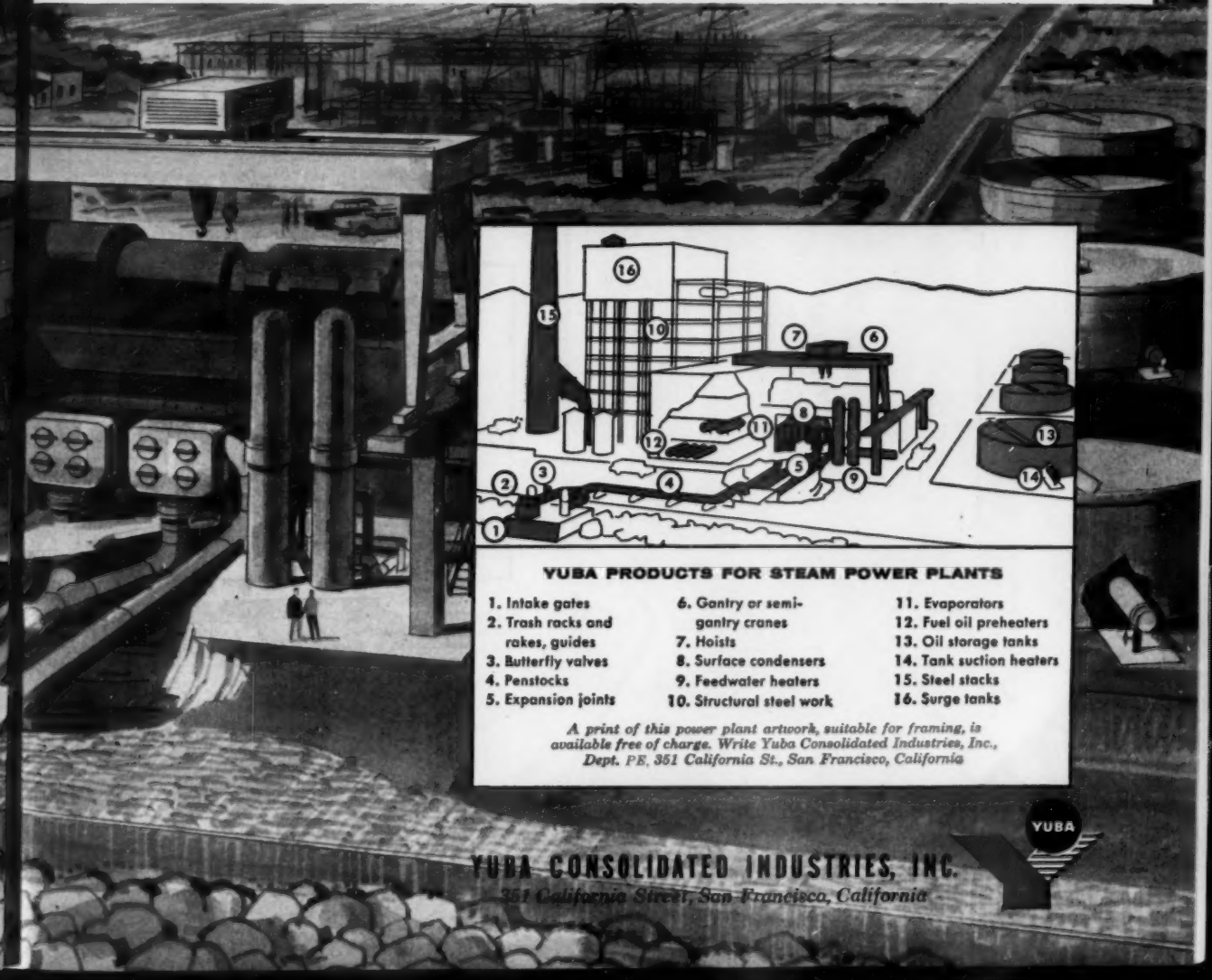

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A print of this power plant artwork, suitable for framing, is available free of charge. Write Yuba Consolidated Industries, Inc., Dept. PE, 351 California St., San Francisco, California

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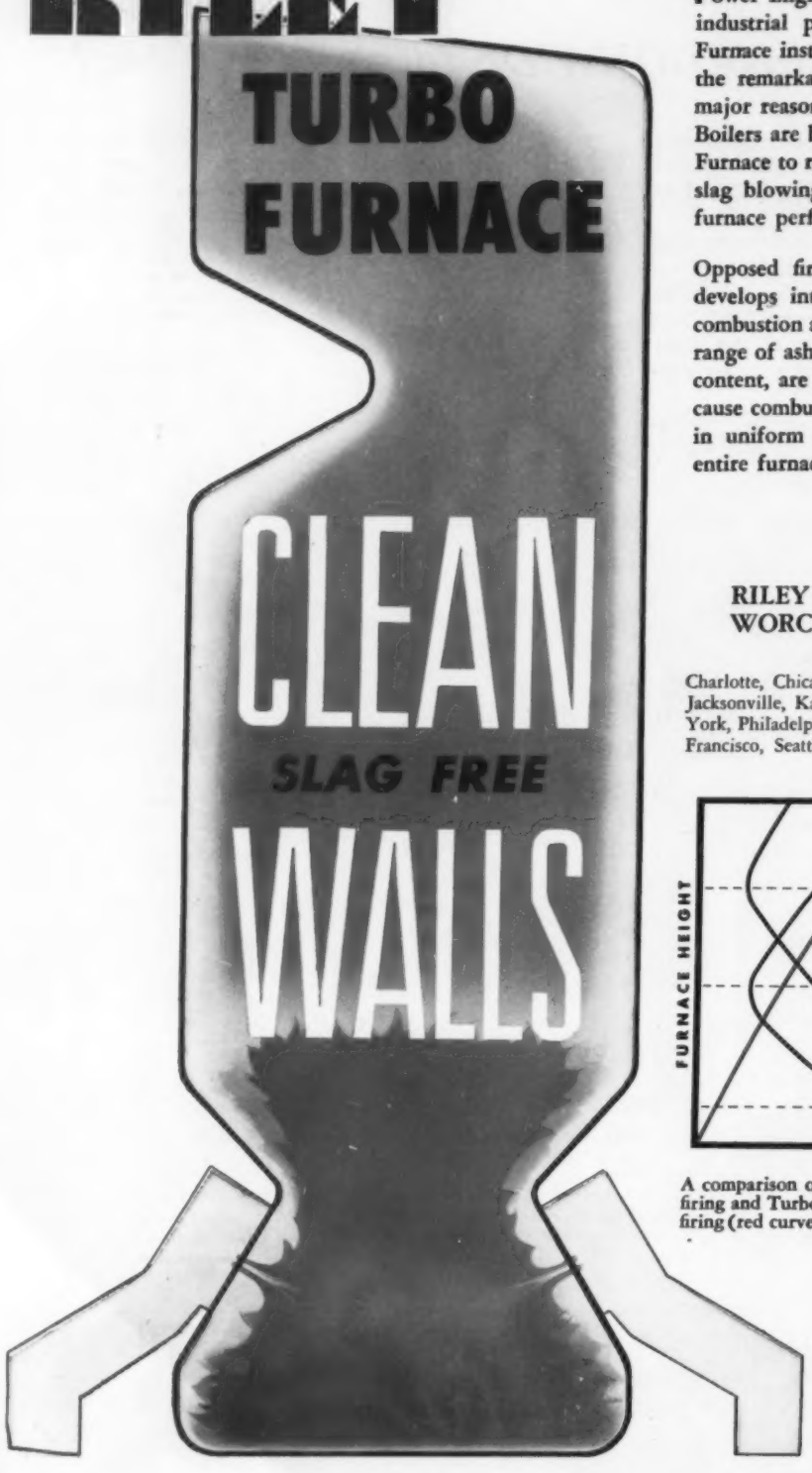
One Of The Many Features Of The

RILEY TURBO FURNACE



Power Engineers of central stations and of large industrial power plants visiting a Riley Turbo Furnace installation burning coal are impressed at the remarkable cleanliness of the furnace . . . a major reason why more and more Turbo Furnace Boilers are being purchased. Ability of the Turbo Furnace to remain slag-free eliminates the need for slag blowing equipment and sustains an efficient furnace performance indefinitely.

Opposed firing into the Turbo Furnace hearth develops intimate mixing of fuel and air, rapid combustion at high temperature. Coals with widest range of ash fusion temperatures, ash and sulphur content, are suitable. Furnace walls stay clean because combustion gas rises vertically out of hearth in uniform stratum without turbulence and fills entire furnace cross section.

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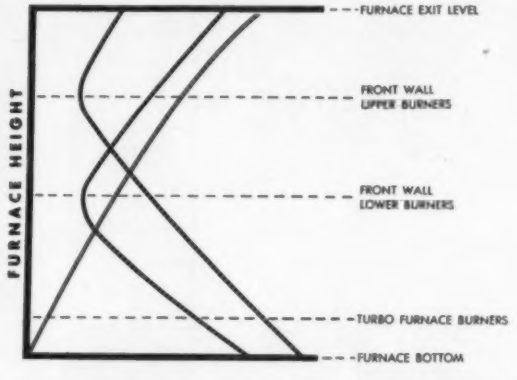
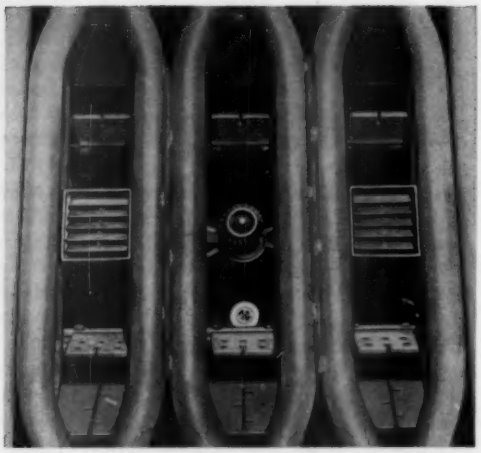


A comparison of temperature characteristics between wall firing and Turbo Furnace firing. Note with Turbo Furnace firing (red curve) highest temperature is at furnace bottom.

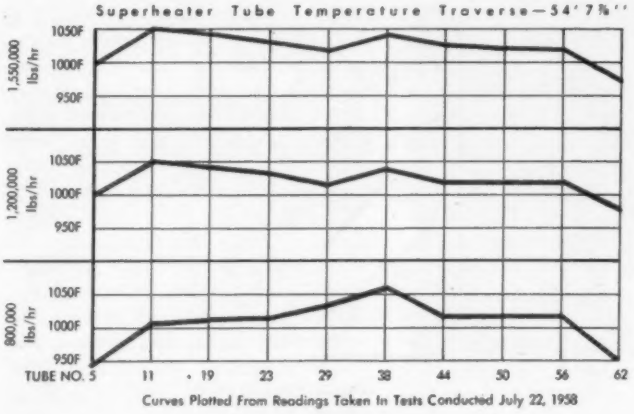
A few of 20 Burners in a 1,550,000 lb/hr Turbo Furnace Boiler. This is a 56 foot wide single furnace.



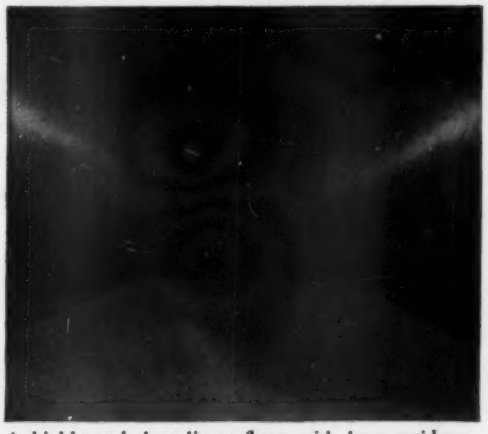
The Riley Directional Flame Turbo Furnace Burner is a shop assembled unit which can be equipped complete with coal, gas, oil burners and automatic gas ignitors. Adjustable vanes direct air to control flame placement. No refractory is needed.

THERE ARE OTHER TURBO FURNACE ADVANTAGES, TOO!

- **Tops For Multifuels** Combustion of coal, oil, gas, fluid coke, produces substantially equal furnace performance resulting in equivalent furnace exit temperatures, simplifying steam temperature control.
- **Eliminates The Flyash Disposal Problem** Reinjected flyash is removed as an easily handled, commercially useful, quenched slag; in some instances flyash from adjacent dry-bottom boiler can be disposed of in the Turbo Furnace.
- **Extra Wide, Undivided Furnaces Are Possible** The opposed method of Turbo Furnace firing removes limitations on furnace width inherent with other methods of firing.
- **Less Space Required** The permissable higher heat release of the Turbo Furnace results in smaller structures for a given capacity.
- **One Level Operation** All Turbo Furnace burners are at one operating level — usually common with the turbine operating level.
- **Minimum Superheater Metal Temperature Variations** Linear flame from side wall to side wall produces uniform heat release throughout the entire furnace width. Furnace gases rise evenly and vertically within the furnace, resulting in a flat gradient of the skin metal temperatures of superheater and reheater tubes.



Curves Plotted From Readings Taken In Tests Conducted July 22, 1958



A highly turbulent linear flame with long residence time of combustibles results from downward opposed firing. Carbon loss is negligible.

The cooled slag pool of a shut-down unit returns to molten stage when unit returns to line. Note slag discharge opening and flyash reinjection ports.

A survey of your plant by a qualified consulting engineer could show ways of making surprising savings in your power costs.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

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HELPFUL WATER CONDITIONING DATA FROM BETZ

A MODERN APPROACH TO

The Dianodic method of corrosion control has revolutionized the treatment of open recirculating cooling water systems

CORROSION is undoubtedly the most widespread, and probably the most costly water caused difficulty that faces industry. The annual cost due to corrosion has been estimated at approximately six billion dollars. A large part of this loss occurs in cooling water systems of various types. The open recirculating cooling water system commonly used in most industries is typical. Prior to the advent of the Dianodic* method for corrosion control, chromate was the most commonly used inhibitor. Chromate concentrations in the range of 200 to 500 ppm often were employed to control corrosion. However, at this treatment level, pitting was not always adequately controlled and the cost of treatment was high.

The Dianodic method, an achievement of Betz research, was introduced approximately a decade ago, and employs a dual treatment of molecularly dehydrated phosphates and chromates over a selective pH range. This method produces effective control over pitting and tuberculation even with the relatively low treatment levels of 40-60 ppm. The superior corrosion protection secured and the low cost of treatment has encouraged wide use of the Dianodic method. Corrosion rates of 1 mil per year or less for steel are common with the pitting function completely prevented or very definitely stifled. Corrosion rates with copper and its alloys are even lower—often less than 0.3 mils per year. Figure 1 illustrates the results secured from an actual operating system.

Continued research at Betz Laboratories has permitted the development of many variations of the original Dianodic method to meet specific requirements for the individual cooling water system and to cope with the many variables that enter into the corrosion problem. The Dianodic methods include—Phosphate Dianodic — Zinc Dianodic — Fluoride Dianodic — Chromium Dianodic—as well as combinations of these methods.

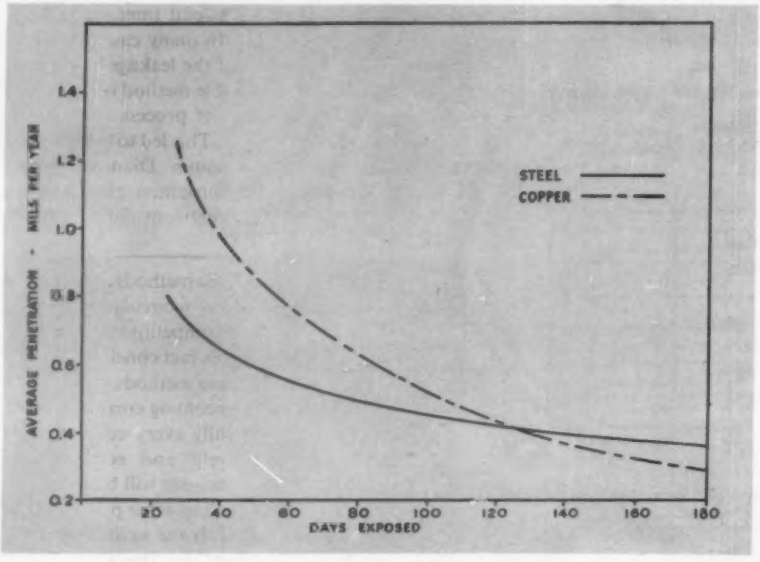

Figure 1—Corrosion results with Betz Dianodic method.

[*Dianodic is a Betz trade name. The methods are covered by U. S. Patents 2,711,391; 2,900,222; 2,872,281; 2,848,299.]

Phosphate Dianodic

The Phosphate Dianodic method which makes use of polyphosphate in combination with chromate over a controlled pH range, eliminates the pitting function that is produced by the individual components when used separately. Figures 2, 3 and 4 illustrate the control of pitting by the Dianodic method compared to phosphate and chromate when used separately. The shallow anodic areas that may develop with the use of this combination treatment have no appreciable depth and are rapidly rendered inactive. In many cases, even these shallow anodic areas do not develop.

Plant results with Phosphate Dianodic have been excellent. Treatment concentrations will vary with the individual operating conditions and may range between 30 and 100 ppm depending on water characteristics, temperature, cycles of concentration, retention time and other factors. Well established rules have been developed through years of experience over a wide range of conditions to permit the selection of the proper treatment levels, proper treatment ratios and pH range to assure maximum protection and the most economical cost for the individual system.

Zinc Dianodic

In spite of the wide coverage permitted by the Phosphate Dianodic method some limitations are encountered where calcium of the makeup water is high or the reversion of polyphosphate to the orthophosphate form is abnormal. Under these conditions it may not be possible to establish or maintain the most effective ratio of phosphate to chromate without encountering deposition of calcium phosphate. In these cases, Zinc Dianodic, another development of Betz research, can be used effectively. The superimposing of zinc on the phosphate-chromate combinations permits a greater latitude on phosphate levels or, at the same phosphate levels, improves corrosion protection. For example, when normal phosphate levels cannot be maintained due to some limiting factor, such as high calcium or a high reversion rate of the phosphate, phosphate level may be decreased and zinc superimposed. In this case, the zinc takes up the slack and acts as a cathodic inhibitor to stifle the corrosion reaction. With the introduction of Zinc Dianodic, even broader coverage is possible and this combination of zinc, phosphate and

chromate minimizes, if not eliminates, most limitations to use of the Dianodic method.

The Zinc Dianodic method is quite versatile and can be operated in the 'soluble range' or the 'coating range'. In the 'soluble range' or film forming range, pH and zinc values are set below the point where zinc phosphate will precipitate. Under these conditions no visible coating is formed except at points where the pH is elevated by local cell action. For example, if local cell action takes place, the area undergoing attack is the anode and the area surrounding the point of attack is the cathode. The cathodic reaction is:

$$\tfrac{1}{2}\ O_2 + H_2O + 2\ \text{electrons} = 2\ OH^-$$

The hydroxide thus formed is sufficient to elevate the pH and cause deposition of zinc phosphate which stifles the cathode reaction.

In the coating range, the zinc and pH are set above the pH of saturation of zinc phosphate which results in a coating formation over the entire system. After the desired coating is formed, the zinc and pH levels are adjusted downward so as to just maintain the coating intact and to repair the coating at any point where cell action may start. In both cases, it can be seen that the function of zinc is one of a cathodic inhibitor or barrier type treatment. Generally, however, the use of the 'coating range' is restricted to the treatment of once through systems.

In the control of corrosion, it is important that rapid film formation be accomplished to stifle the corrosion reactions. The use of Zinc Dianodic permits rapid film formation and is an excellent pretreatment for steel heat exchangers. Passivation of the steel surfaces can be accomplished in as little as two hours with treatment levels of 500 ppm or lower depending on temperature. The film thus formed can then be maintained with the normal treatment levels. Consequently, the fouling and high pressure drops that develop from the initial corrosion and tuberculation can be minimized or eliminated.

Fluoride Dianodic

Fluoride Dianodic, another development of Betz research, is designed to handle waters contaminated with aluminum. Surface supplies that are turbid must be clarified to remove suspended solids that would otherwise settle on heat transfer surfaces. It is common practice, to coagulate and settle surface supplies without the benefit of filtration when the water is used as makeup to open recirculating systems. The low turbidity from the modern type clarifier usually permits this practice. However, where aluminum is used as a coagulant and floc carryover takes place, fouling of the heat exchangers with aluminum deposits can result. Aluminum hydroxide and aluminum phosphate are most commonly encountered. The presence of aluminum interferes with the Phosphate Dianodic method by forming a soluble aluminum polyphosphate complex. The Fluoride Dianodic method makes use of the fluoride ion to preferentially complex the aluminum ion. The soluble complex thus formed acts dianodically with chromate and aids in avoiding fouling and stifling of corrosion.

Chromium Dianodic

The original applications of Phosphate Dianodic to many refinery cooling water systems uncovered many incidences where leakage from the process side was taking place. Where sour crudes are being processed, the leakage contaminates the cooling water with hydrogen sulfide, mercaptans and organic matter. Formerly, such leakage went undetected for appreciable periods of time and usually was discovered only after extensive damage was done to the system. With the application of Dianodic, the chromate component of the treatment is reduced by these contaminants to trivalent chromium and leakage is readily detected. Where possible the leakage should be corrected immediately to minimize the heavy corrosion load imparted by hydrogen sulfide. In many cases, immediate correction of the leakage is not possible and a suitable method of treatment in the presence of process leakage becomes necessary. This led to the development of Chromium Dianodic which makes use of chromium phosphate as a barrier type treatment during periods of leakage.

The Betz Dianodic methods are the most effective for open recirculating cooling water systems. Competitive studies have demonstrated this fact conclusively. The versatility of these methods makes them suitable for overcoming corrosion problems in practically every cooling water system—effectively and economically. A Betz Field Engineer will be pleased to discuss your cooling water problems and acquaint you with the savings that can be accomplished by the use of Betz Dianodic methods. A good time to call him in is *today!*

BETZ LABORATORIES, INC.
Gillingham & Worth Streets • Phila. 24, Pa.

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

COOLING WATER TREATMENT

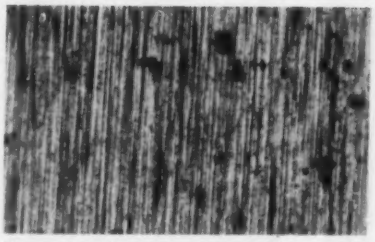

Figure 2—Chromate pits at 18 magnifications.

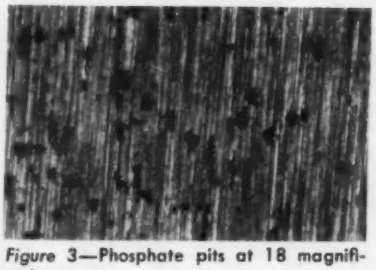

Figure 3—Phosphate pits at 18 magnifications.

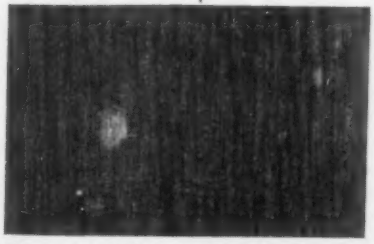

Figure 4—Shallow anodic areas from the Dianodic method at 18 magnifications.

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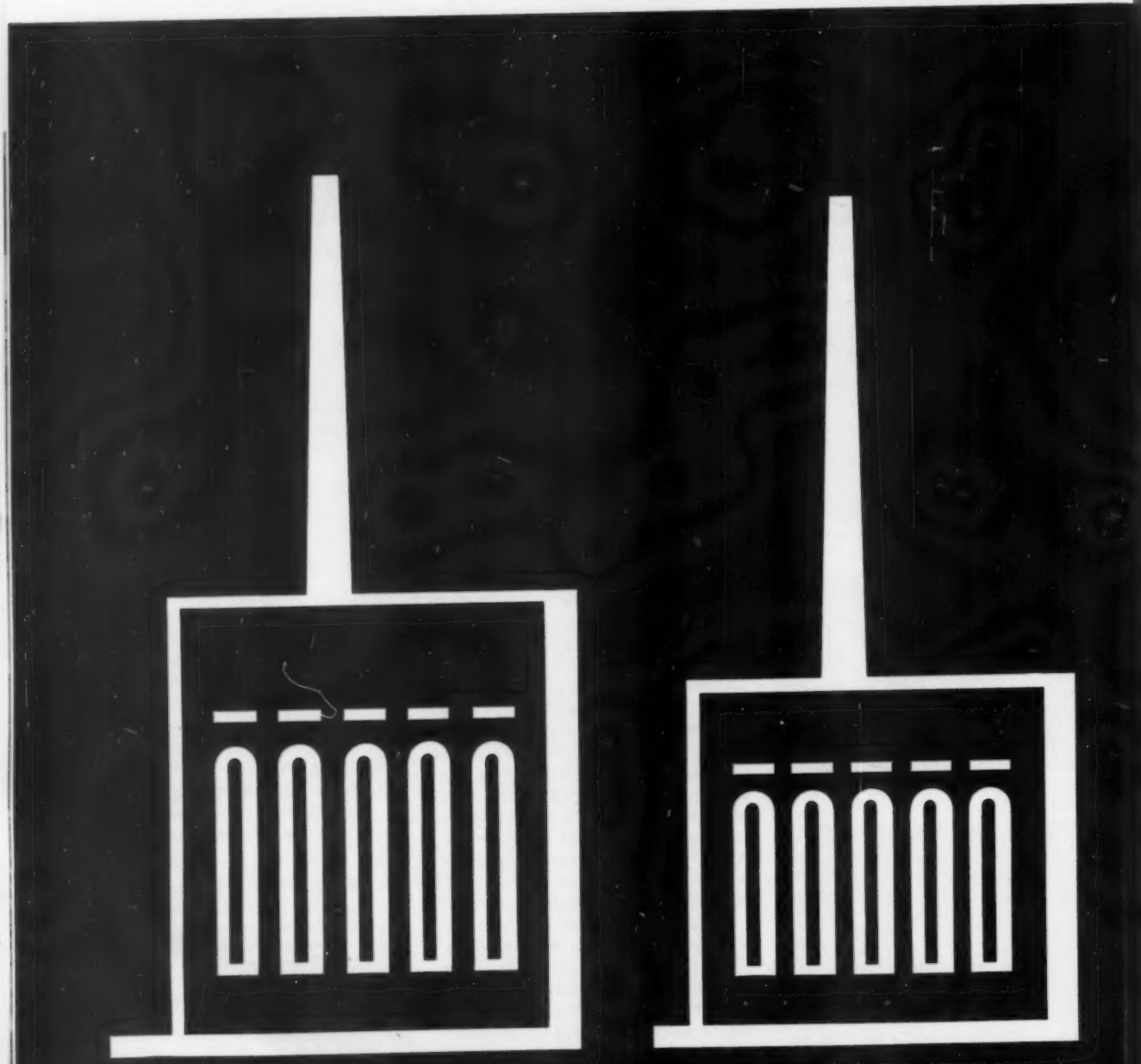
Gas Tempering: **Report No. 3**

Electric Utilities Cut Costs With



Over-All Plant Gas Tempering

...Smaller Buildings Per KW
...Less Structural Steel
...Lighter Foundations
...Shorter Steam Leads

Historically, the size of steam generating equipment has been based on two main considerations: space needed to burn fuel, and surface required to cool gases before they reach the convection surface. Boiler designers have long known that to cool the gases, they had to use furnaces much larger than required if complete combustion of the fuel were the only consideration. Now with the proved-in-operation principle of Gas Tempering, the surface requirements to cool furnace exit gases are substantially less.

What is Gas Tempering? . . . it is the reintroduction of cool flue gases near the furnace outlet to control the temperature of the furnace gases entering the convection surface.

From The Foundation Up, Electric Utilities are finding B&W Gas Tempering the most effective method of controlling temperatures of gases leaving the furnace . . . with a unit that is designed for minimum weight, height and bulk.

Definitive Booklet: If you'd like to learn more about the economies and design flexibility available to you through Gas Tempering, write for Bulletin G-96. Address: The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

Major Advantages of B&W Gas Tempering

. . . It cuts overall plant costs because the smaller size unit requires a smaller building per kw, a lighter foundation, less structural steel and shorter steam leads.

. . . It enables you to utilize the most economical available fuels. It permits the burning of a variety of coals without slagging, minimizes external corrosion of superheater tubes, and assures safe metal temperature, thus prolonging tube life, regardless of the fuel fired.

. . . It provides safe superheater tube temperature by positive gas temperature control; it protects superheater during startup and under all operating conditions.

. . . It makes it safer to design for economies offered by operation at steam temperatures of 1050 F and above.

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

G-933

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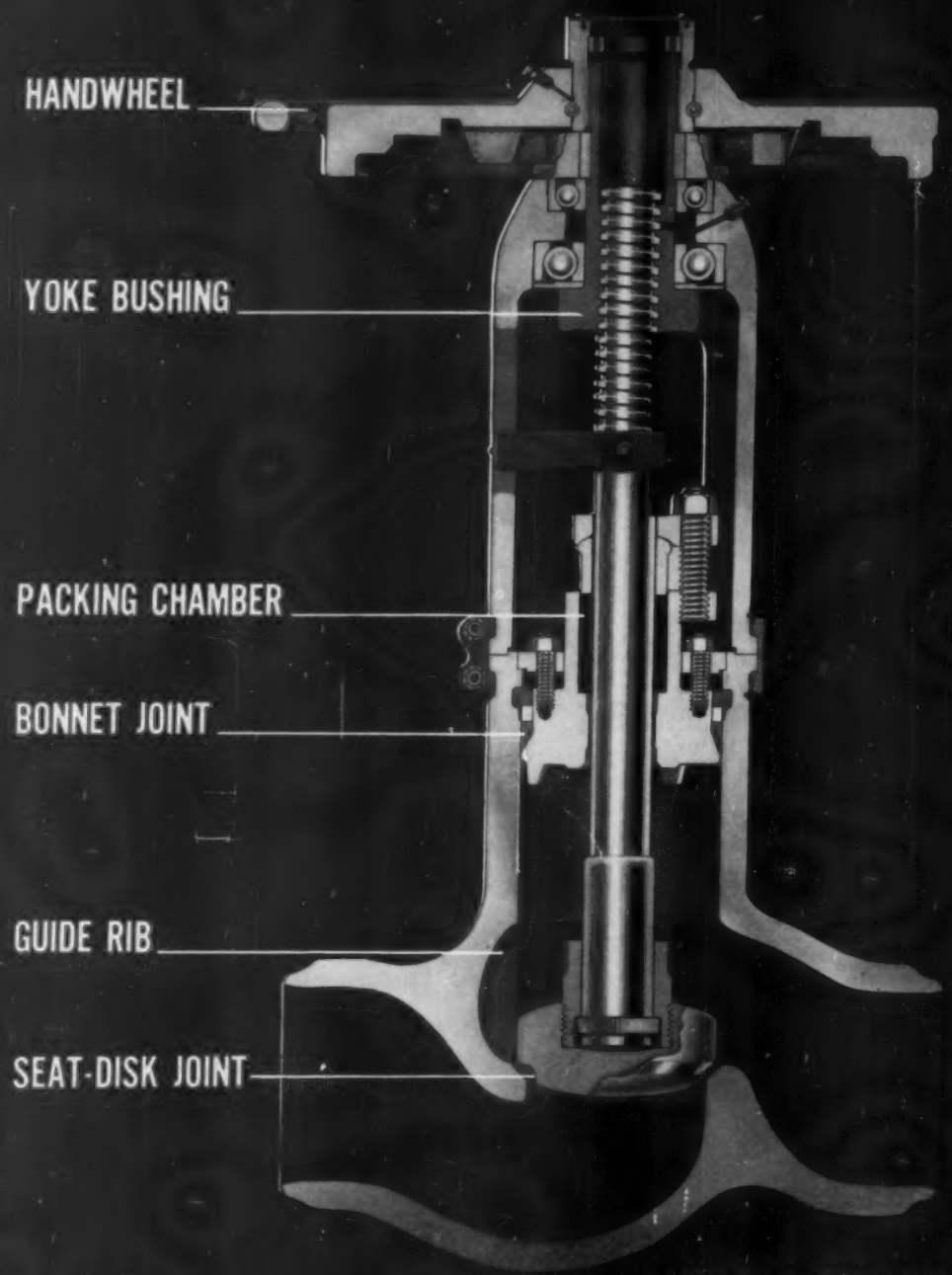
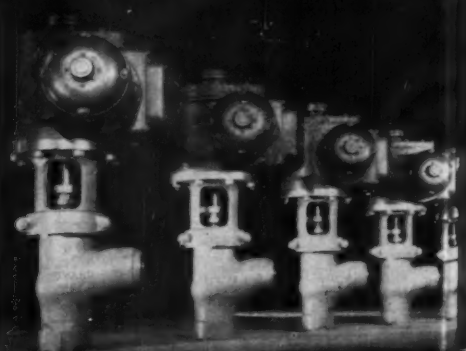


EDWARD CAST STEEL
GLOBE VALVE FIG. 4016Y

IMPACTOGEAR® OPERATED VALVE

MOTOR OPERATED VALVES



What's New from Edward Valves

New Products . . . Solutions to Problems . . . Information on Steel Valves from Edward, Long-Time Pioneer in the Field!

HOW TO SELECT CAST STEEL VALVES

Valves for today's high-pressure processes require economy, dependability and safety in operation. The material on these pages is designed to help acquaint you with a few basic principles and features you should consider when selecting cast steel valves 2½ inches and larger.

VALVE FEATURES FOR LONGER LIFE, EASIER OPERATION

Valve Handwheel should be large enough to operate valve easily. On smaller valve sizes, a knobbed handwheel design permits tighter grip. But for larger, high-pressure valves, impact-type handwheels will increase closing force, insure tighter closure (see large illustration opposite page). Quick closing can be obtained with impact-type handwheels geared for closing with the aid of portable air or electric wrenches (bottom-left, opposite page). Or, where central or automatic control is desired, consider fixed motor operation (bottom-right, opposite page).

Yoke Bushing on larger valves in higher pressure classes should be equipped with double ball-bearing construction for reduced operating torque and effective transmission of closing load (large illustration on opposite page shows this design). Material is important, too. On smaller valves, bushings of bronze will help prevent stem seizing or galling. Look for ample thread engagement between bushing and yoke and between bushing and stem.

Packing Chamber should be large enough to insure long packing life. Valve packing must allow the stem to move within the bonnet but must not allow any fluid leaks between them. Well made packing, formed specifically for the packing chamber and correctly compounded for your pressure-temperature service conditions, has much to do with satisfactory valve performance. Valves with a positive backseat for re-packing while under pressure offer additional operating advantages.

Bonnet Joint of bolted construction (see Fig. 618 this page) is easiest to work with on medium or small size valves. But for lasting bonnet joint tightness, in high-temperature services (and for reduced size and weight), pressure-seal bonnet joint design is best—no flanges or bolting to periodically restress (see large illustration opposite page). Not all pressure-seal designs are alike, however. Avoid gaskets with small sealing surfaces and sharp edges that can be easily damaged and large threaded gasket loading mechanisms that are hard to disassemble and give unknown gasket compression.

Disk Guiding that properly centers the disk into the seat for positive shut-off regardless of position is important. Valve bodies with integrally cast guide ribs supporting disk throughout travel are best. Avoid designs which attempt to guide by installing spider in seat opening.

Seat-Disk Joint—An integral hard-faced seat is generally regarded as superior to screwed seat construction because it eliminates body-seat leakage and retains hardness under temperature. A hard-faced disk or disk of special alloy is desirable in high temperature services; but 13 per cent chromium stainless steel is an excellent all purpose material below 750° F.

Body Design with streamlined flow passage areas (opposite page) reduces wear-producing turbulence, decreases pressure drop and delivers maximum flow. Valves with streamlined body contours will often permit the use of smaller pipe and valve sizes. Angle valves (see Fig. 7517Y, upper right) have even less pressure drop.

For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame Street, W., Montreal 1, Quebec.

Edward Valves builds a complete line of cast steel stop, check, non-return, stop-check and gate valves for pressures to 10,000 lbs. available with flanged or welding ends. Below are illustrated a few of the major valve designs from this complete line.

Fig. 7517Y
Angle stop valve, 1500 lb at 850 F. (3600 lb WOG), with integral Stellite seat, Stellited disk, pressure-seal bonnet, welding ends. 2½" to 14".

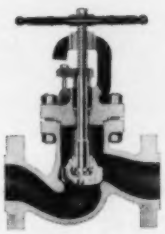


Fig. 618
Globe stop valve, 600 lb at 850 F. (1440 lb WOG), bolted bonnet, flanged ends, integral Stellite seat, Stellited disk. Sizes 2½" to 6".

Fig. 607Y
Angle non-return valve, 600 lb at 850 F. (1400 lb WOG), with pressure-seal bonnet, integral Stellite seat, Stellited disk-piston, welding ends, sizes 8" to 14".

Fig. 611—Gate valve, 600 lb at 850 F. (1440 lb WOG), with hard-surfaced seats and wedge, ball bearing yoke, flanged ends. Sizes 2½" to 12".

Fig. 4094Y—Horizontal check valve, 900 lb at 850 F. (2160 lb WOG), with integral Stellite seat, Stellited disk-piston, pressure-seal cover, welding ends. Sizes 2½" to 14".

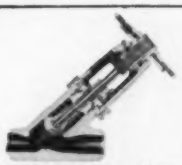


Fig. 7514—Flite-Flow globe stop valve, T500 lb at 850 F. (3600 lb WOG) or 2500 lb at 850 F. (6000 lb WOG), with extremely low pressure drop and other premium features. Sizes 10" to 18".

EDWARD STEEL VALVES
another fine product by
ROCKWELL

Catalog 14 contains full data on the complete Edward line of forged and cast steel valves from ¼" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 10,000 lbs; with pressure-seal, bolted, union or welded bonnets, with screwed, welding or flanged ends.

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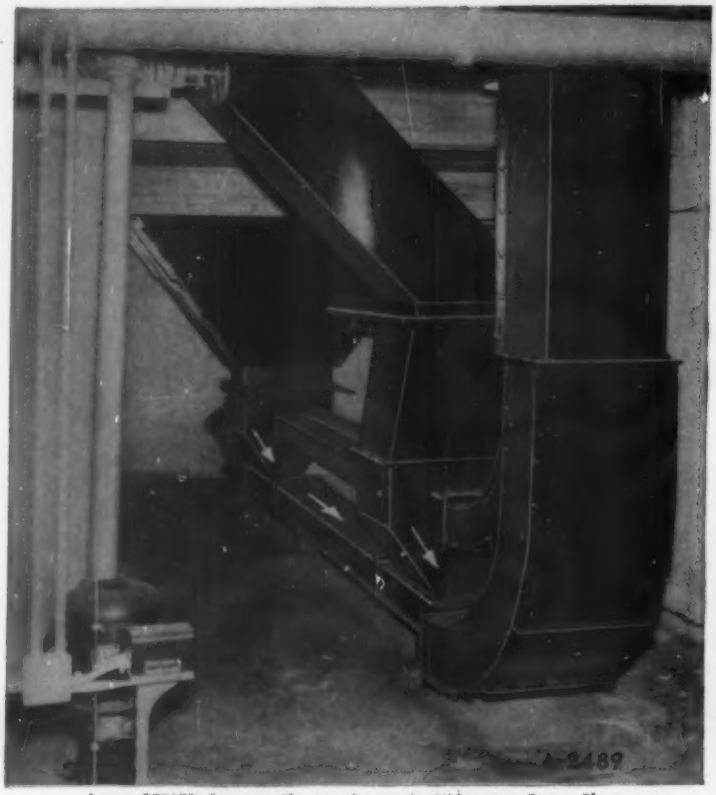
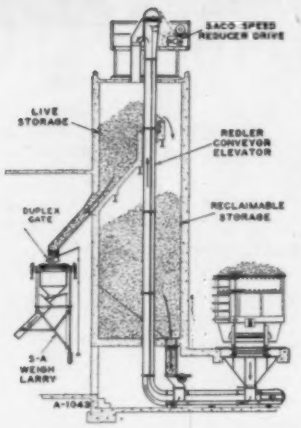
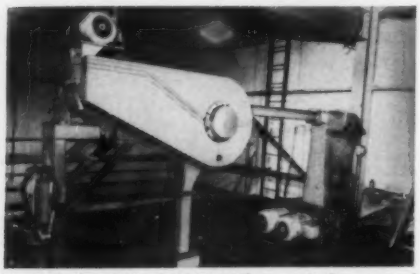
STEPHENS-ADAMSON



L-type REDLER Conveyor-Elevator System in Midwestern Power Plant



Drawing above illustrates flow of coal through a typical REDLER Conveyor-Elevator installation.

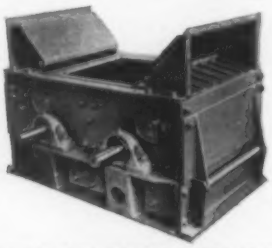


Vertical Closed-Circuit REDLER Elevator discharges coal into double-roll Knittel Sampling Crusher. Coal "cut" from main flow is sampled for B.T.U. content.

REDLER® Conveyor-Elevator ...LOWERS COST IN COAL HANDLING! INCREASES EFFICIENCY

S-A HYDRAULICALLY POWERED CARQUAKE — Maximum efficiency in unloading hopper cars *without* objectionable noise. One man controls operation. No expensive overhead structures — a completely self-contained unit. 2 types available.

WRITE FOR BULLETINS 358, 858 and 658



S-A RING TYPE DOUBLE ROTOR KNITTEL CRUSHER — Crushes lumps while in suspension . . . no breaker plates needed. Maintains full capacity with wet coal — no clogging. Greater capacity—less space required.

S-A
MATERIALS HANDLING PRODUCTS
SEALMASTER BALL BEARING UNITS

STEPHENS-ADAMSON engineered REDLER Conveyor-Elevator Systems backed by over a half century of coal handling "Know-how" provide dependable coal handling service at the lowest cost-per-ton figured over the life of the equipment. In the Midwestern installation shown above, an L-type REDLER Conveyor-Elevator System handles distribution from an unloading hopper to a storage silo and from reclaimable storage to live storage shelf or direct to boiler room. Dust is confined within the sealed REDLER casings thereby contributing to good housekeeping. S-A REDLER coal handling systems save space, offer flexibility in application and often combine both conveying and elevating operations usually with only one drive.

REDLER Conveyor-Elevators are available in sizes to handle practically any tonnage. They can be designed to fit into any new or existing structure and will occupy a minimum of space.

ENGINEERING DIVISION
STEPHENS-ADAMSON MFG. CO.
GENERAL OFFICE & MAIN PLANT, 86 RIDGEWAY AVENUE, AURORA, ILLINOIS

PLANTS LOCATED IN: LOS ANGELES, CALIFORNIA • CLARKSDALE, MISSISSIPPI
BELLEVILLE, ONTARIO

For more data circle 514 on Post Card

HELPFUL BULLETINS

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 123 and 124.

VALVES, PIPING, FITTINGS

101 Iron Body Gate Valves — Service ratings, sizes, dimensions and material specifications are listed in this bulletin on iron body gate valves for construction, gas transmission, chemical, electric and petroleum fields. Cast iron wedge gate valves listed for steam, water, oil and gas. Walworth Co.

102 Air Check Valve — Bulletin 125–14 gives descriptive data and specifications on air check valves offering positive seating, vertical or horizontal installation, and non-slam and non-chattering characteristics. Explains design features which contribute to valves' improved performance. Combination Pump Valve Co.

103 High Vacuum Equipment — Valves, baffles and traps designed for high vacuum equipment are featured in 28-pp Bulletin 10–1. Features and methods of operation are detailed and photos, dimensional data and diagrams and other selection data are included. Rochester Div., Consolidated Electrodynamics Corp.

104 For Nuclear Industries — Complete data on valves for a wide variety of nuclear and chemical applications is presented in 190-pp Bulletin A-155. Includes information, diagrams, and charts on current line of valves, as well as engineering charts, corrosion resistance tables of 15 metals and over 400 corrosive media in various conditions, conversion tables, valve flow capacity charts. Associated Valve Co.

105 For Precision Control — Pressure regulators, strainers, flow control valves, sequence valves and quick exhaust valves are described and illustrated in Bulletin 91021, 8 pp. Specifications, outstanding features, ordering data and dimensions are also included. Airmatic Valve, Inc.

106 Plastic Pipe — Featured in 16-pp Bulletin CE-80 is Ace Ite, general purpose rigid plastic pipe for processing industries, utilities, and general industrial use. Contains detailed technical data covering fittings and valves as well as pipe. American Hard Rubber Co., Div. Amerace Corp.

BOILERS, HEAT EXCHANGERS

107 Packaged Boilers — A complete discussion of firetube boilers — from construction features to final test and start-up service — is presented in 12-pp Bulletin Form AD 178. Full-color cutaway drawings illustrate features and design of packaged boilers through 600 hp for heating and processing, steam or hot water. Cleaver-Brooks Co.

108 Unit Steam Generator — Bulletin 3000 describes features and advantages of a fully automatic unit steam generator for light oil, heavy oil, gas, and combination gas-oil applications. Tables of steel specifications of pressure vessel, engineering and dimensional data are included. Preferred Utilities Mfg. Corp.

109 Heat Transfer Equipment — Described in condensed Bulletin 593 are heat exchangers, fired indirect heaters, tank heaters, tank suction and line heaters, process heaters and coolers, packaged boilers, and custom built equipment. Includes descriptive and engineering data on the various types of equipment. Brown Fintube Co.

110 Heat Exchangers — Bulletin 113 describes five types of fired heat exchangers covering temperature ratings up to 1900 F, flow rates of air up to 550 lb/sec, and pressure ratings up to 5000 psig. Photographs of installations are included. Thermal Research & Engineering Corp.

111 Heat Exchangers — Design and application of company's standard heat exchangers is covered in 20-pp Bulletin B-20. Complete mechanical design data, and thermal rating tables allow easy selection of units for a range of services, including heating, cooling, condensing and vaporizing. Struthers Wells Corp.

MECHANICAL POWER TRANSMISSION

112 Control Drives — High torque control drives are featured in the revised version of Product Specification PS1-1. Four sizes, producing torques from 50 to 2250 ft-lb, and suitable for special high temperature applications to 250 F are described. Bailey Meter Co.

113 Gear-Motors — Design and construction features of gear-motors from ¼ to 100 hp are described in Bulletin 51B9172. Included are integral and all-motor types, right-angle and special designs. Allis-Chalmers Mfg. Co.

114 Variable-Speed Pulleys — Twelve-pp Bulletin 4101 describes variable-speed pulleys designed to eliminate freezing and sticking. Includes tables giving technical data, as well as dimensional diagrams and horsepower ratings. T. B. Wood's Sons Co.

115 Adjustable Speed Drives — Bulletin GEA-6806, 16 pp, describes a ¼- to 25-hp line of mechanical adjustable speed drives. Discusses principles of operation, configurations and features, and includes mounting positions, rating tables, accessories. General Electric Co.

116 Flexible Couplings — Eight-up revised Bulletin 597 outlines features required of a flexible coupling, including simple construction, accommodation of angular and parallel misalignments with minimum backlash, easy installation. Also tells how to select flexible couplings and shows installation and maintenance procedures. Chain Belt Co.

117 On Fretting Corrosion — The several ways in which fretting corrosion in variable-speed sheaves can be controlled are discussed in Bulletin 7102. Details are clarified through photos, sketches and diagrams. T. B. Wood's Sons Co.

118 Spring Clutches — Described in this 30-pp catalog are five standard lines of spring clutches in bore sizes from ⅛ to 1 in., torque capacity to 1250 lb-in., for use in applications utilizing drive up to 5 hp. Clutches offered include over-running and back-stopping: indexing: on-off; on-off indexing; and safety lock control. Catalog lists specifications and provides technical and application data, illustrations. Marquette Div., Curtiss-Wright Corp.

PUMPS, COMPRESSORS

119 Heavy Duty Pumps — Triplex pumps designed to withstand high pressures, high temperatures and continuous duty are described in 12-pp Bulletin 259. These are plunger type pumps for pressures to 20,000 psi and displacements to 58 gpm. Features are illustrated and some installations pictured. Kobe Inc.

120 Internal Gear Pumps — Featured in this illustrated bulletin are internal gear rotary pumps for continuous operation in transferring medium to high viscosity liquids. Construction and performance data, as well as dimensional data and diagrams are included. The Wayne Pump Co.

121 Standardized Vertical Pump — This folder describes the high measure of pump standardization achieved with the Veriflow pump, a vertical single stage unit covering the range of 1- to 4-in. pumps for petroleum, chemical and general industrial use. Time-saving installing, economy are stressed, and design features cited. United Centrifugal Pumps.

122 Proportioning Pump — Bulletin 1107.20–1 describes a plunger-type, small capacity proportioning pump for treating of small, low pressure boilers. Contains photo of pump, engineering and dimensional data, list of chemicals handled. B-I-F- Industries, Inc.

123 Air Compressors — Stationary air compressors for continuous, heavy duty service in industry are illustrated and described in Bulletin A-62. Contains specifications, diagrams, cross section drawings, and installation photos. Joy Mfg. Co.

124 Compressed Air Fundamentals — Sixteen-pp Form 1548 is intended to aid in selection of a small, "packaged" air compressor. Discusses compressed air, how it is compressed, single- and two-stage compressors, piston displacement, control used etc. Includes information on compressor oils, pipe sizes, wire sizes, terminology. Also provided is data on cubic feet of air required to operate a variety of pneumatic equipment, air supply tables, cylinder diameter requirements, chart on ratios of compression and tables on flow of air through orifices. Ingersoll-Rand Co.

ELECTRICAL

126 Motors, Generators — This product bulletin, 6 pp, lists squirrel-cage

a-c motors, special purpose motors, wound-rotor motors, direct current motors, generators and motor-generator sets. All are illustrated. Range of motors covered is from 1 to 200 hp; motor-generator sets from ½ to 150 kw. Imperial Electric Co.

127 Reversing Capacitor Motor — Described in 8-pp Specification S 1016-2 is a line of reversing capacitor type motors, with integral strain release and stroke adjustment. Includes detailed specifications, dimensional data and diagrams. Minneapolis-Honeywell Regulator Co.

128 Compact Substation — Bulletin GEA-6978 describes super-compact substation for application on long, lightly loaded rural or suburban power lines. It consists of a three-phase medium transformer — rated 501 to 7500 kva, 69 kv and below — and one transformer-mounted oil circuit recloser. Charts show load current ratings and substation arrangement of elements. General Electric Co.

129 Pre-Fab Distribution System — Safety and other advantages of company's Uni-Bus Masterguard electrical distribution system are detailed in this 28-pp bulletin. Describes features of various components in the prefabricated system, and includes rating tables, table for selection of ampere ratings, capacity data, dimensional data and specifications. Electric Distribution Products, Inc.

130 Underfloor Systems — Two underfloor wiring systems for use with cellular steel floor construction are described and illustrated in Form 692. Application data, catalog numbers and guide form specifications are included. National Electric Div., H. K. Porter Co., Inc.

131 Motor Control Centers — Design features of company's Uni-Bus motor control centers are stressed in 24-pp Bulletin UM-100. Safety advantages, as compared to conventional equipment, are detailed in text and illustration. Specifications and dimensions are presented, also a typical wiring diagram. Electric Distribution Products, Inc.

132 Distribution Switchboards — Bulletin 2015, 6 pp, describes shallow-depth switchboards through 2000 amp. Designed to aid in centralizing power distribution, it shows how eight basic sections can be combined to meet individual switchboard applications. Three types are covered: incoming line section, distribution sections and combination metering and distribution sections. Each section is described and illustrated with photos and cutaways. General and construction features are covered; and information on ratings, layout, dimensions and specifications provided. Federal Pacific Electric Co.

133 Power Switching Centers — Detailed application and design information on power switching centers featuring building block design is presented in 20-pp Bulletin 1616A. Illustrates such standard cubicle components as potential and current transformers, lightning arresters, potheads and key interlocking safety equipment, and includes schematics of entrance and feeder arrangements, with dimensions and sample specifications. I-T-E Circuit Breaker Co.

134 Time Overcurrent Relay — Bulletin 5-050, 16 pp, describes time overcurrent relays designed to protect electrical equipment. Three different designs — inverse, very inverse, and extremely inverse — are featured, and complete technical data on operating characteristics is given, including individual time-current characteristic curves. Federal Pacific Electric Co.

135 Circuit Breakers — Featured in 8-pp Bulletin 4261-2B are individually enclosed low-voltage power circuit breakers featuring visible break disconnect contacts. Selection chart, application data, and coil ratings given. I-T-E Circuit Breaker Co.

136 Power Circuit Breakers — Illustrated 20-pp Bulletin GEA-6908 describes company's air blast power breakers for high-voltage circuit protection. Explains how full range of transmission voltages can be supplied from one basic interrupter module. General Electric Co.

137 General Purpose Breakers — General purpose d-c circuit breakers — Type FB high-speed current-limiting units — are described in Bulletin S-4601-1A. Illustrates and describes design features, performance, applications, and gives ratings, dimensions and weights. I-T-E Circuit Breaker Co.

138 Safer Circuit Breaker — Bolted connections, coil protection and other advantages of Pushmatic circuit breakers are stressed in this 12-pp bulletin. Details of design and operation are illustrated. Bulldog Electric Products Div., I-T-E Circuit Breaker Co.

139 Do-It-Yourself Transformer — Eight-pp Bulletin TP659 describes a do-it-yourself, self-contained toroidal primary coil complete with five-way binding posts for connections. Includes wiring diagrams, typical calculation, useful load voltages, and specifications. The Superior Electric Co.

140 Panel Instruments — Described in 24-pp Bulletin 3–15 is a full line of panel instruments, including a-c meters, d-c meters, elapsed time meters, shunts and current transformers. Photos, dimension drawings, tables of ratings, and complete descriptive data are given, along with construction details and sectional views. Federal Pacific Electric Co.

141 Evaluating Meter Accuracy — Eight-pp publication GEA-5585A provides a method of obtaining logical and useful conclusions from studies of meter accuracy data. Publication explains method and illustrates its applications to practical metering problems. General Electric Co.

> When ordering catalogs, allow time for us to relay your requests to the manufacturers—and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

142 Power Factor Capacitors — Bulletin 32B9421, 8 pp, describes construction features of substation and pole-mounted power factor capacitors. Ratings of 25 and 50 kvar in 2400 through 7960 v are available. Cutaway view shows capacitor's design advantages. Allis-Chalmers Mfg. Co.

143 Mica Insulation — Sixteen-pp Catalog 59 describes and illustrates company's line of Micabond bonded mica insulation, offering information on properties, tolerances and composition of various grades, including four new ones. Data on forms, sizes, weights are provided, and types of backings and bonding materials are treated. Fabricating aids, such as how to punch, turn, saw and drill the material, given. Continental-Diamond Fibre Corp.

DUST AND FUME CONTROL

144 For Cleaner Steel Mills — Sixteen-pp Bulletin 234-PI describes three major areas where need for air cleaning is most acute — at blast furnace, at rolling mill, and wherever comfort air conditioning is prescribed. Also considers filter locations, recommended sizes and types of air filters for particular application, dust problems, maintenance and ventilation, and includes photos, schematic drawings and graphs. American Air Filter Co., Inc.

145 Gas Scrubbers — Generously illustrated Bulletin 203-C, 8 pp, presents high-efficiency, direct-contact gas scrubbers for removal of particulate matter, including sub-micron dust and fume, and absorption of gases and vapors: capacities to 250,000 cfm. Operational principles are explained, and descriptions of typical applications are illustrated by photos and flow diagrams. Peabody Engineering Corp.

146 Wet-Type Collector — Described in this 6-pp bulletin is the Hydro-Filter, a wet-type dust collector for collection of dust fumes. Includes dimensions, specifications and capacity data for four models, capacities from 1000 to 40,000 cfm. Operation, application and advantages of the Hydro-Filter are covered. National Dust Collector Corp.

INSTRUMENTS AND CONTROLS

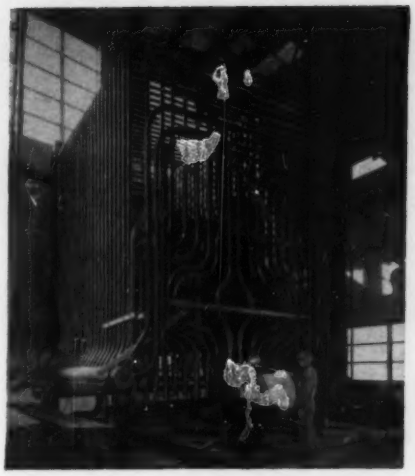
147 Automation Systems — Bulletin 3019 describes systems for full-scale automatic control in plants, refineries and pipelines. Photos and drawings are included. Consolidated Systems Corp.

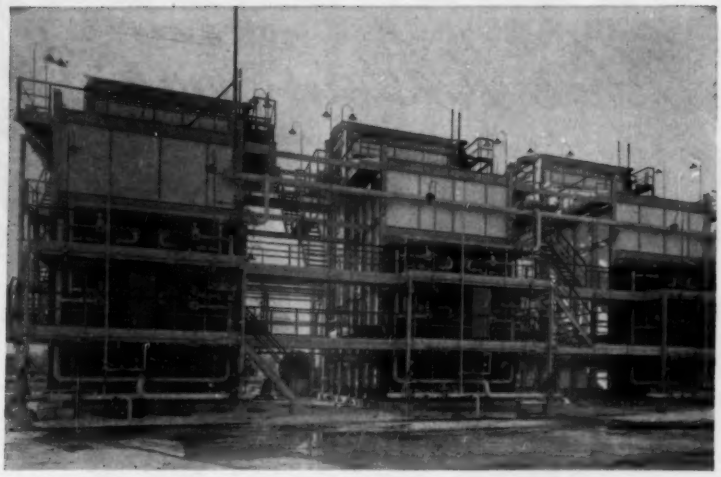
148 Instrumentation, Control — Eight-pp Bulletin 59-C091 (297) is divided into sections for convenient use. Sections 2 through 6 list instruments according to major process variables — pressure, flow, temperature, level and gas analysis. Section 7 lists receivers. Section 1 describes all-electric combustion control systems. Descriptive and specification data for each are provided. The Hays Corp.

149 Transmitting Instrument — Descriptive information on company's Master Controller, an automatic sensing and transmitting instrument that controls pressure or temperature by proportioning of process or combustion rate to load demand, is given in Catalog CMC-687. Specification, description of components, application data, installation and adjusting instruction, dimensions, wiring diagrams included. Cleveland Controls, Inc.

150 Indicating Recorders-Controllers — Electronic indicating recorders and indicating recorder-controllers are described in Bulletin 66. Catalog describes and gives applications for both units, provides information on sensitivity, accuracy, control and alarm function, installation, operation and maintenance. The Thermo Electric Co., Inc.

151 Meter Relay — Bulletin S-2 describes the CRMR, a continuous reading





AT LEFT: Installing a 60,000 lbs/hr unit in a brewery

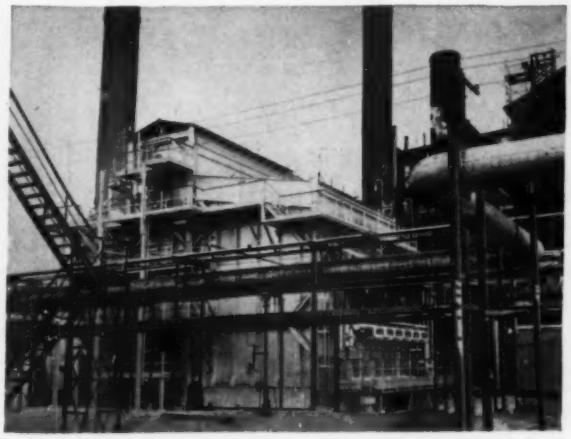
ABOVE: A battery of 125,000 lbs/hr units in a chemical plant

CUSTOM *Steam* GENERATORS by Vogt

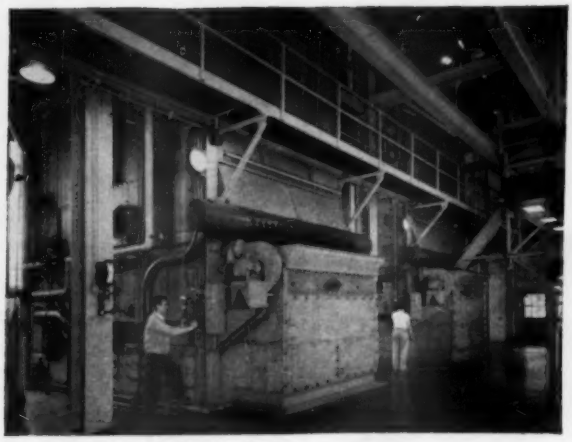
Vogt engineering advances can save you money if you have a steam generating problem. Custom-built installations shown, are engineered to assure efficient, dependable steam generation for power, process and heating. Our engineering staff is available to give effective help in the solution of steam generating problems peculiar to a wide variety of operating conditions. Address **Dept. 24A-BPE.**

HENRY VOGT MACHINE CO.
LOUISVILLE, KENTUCKY

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati



This 400,000 lbs/hr unit is installed in a leading petroleum refinery



Three 40,000 lbs/hr units serve a medical center

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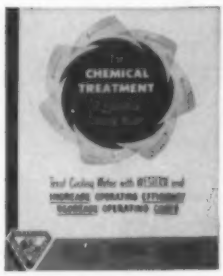
Write Western Today!

For these technical bulletins on

Water, Steam & Fuel Treatment

The Chemical Treatment of Boiler Feed Water. This technical bulletin contains a clear explanation of the causes of boiler water problems and Western's methods of solving them. Special emphasis on scale prevention, corrosion control, sludge dispersion, and suppression of foaming and carry-over.

Steam Plus CORAVOL Equals Protection From Corrosion. This technical bulletin tells how CORAVOL, the original amine process, gives complete protection from corrosion to your entire steam-condensate circuit. Clearly explains the theory of corrosion and the application of volatile amines to steam systems. Cites typical case histories of the use of CORAVOL in various plants and industries.



The Chemical Treatment of Industrial Cooling Water discusses common cooling water problems—scale, corrosion, algae, slime. Also presents Western's proven methods for controlling and preventing these conditions in cooling towers, evaporative condensers, process heat exchangers, engine and compressor jackets, chilled water systems, etc.

Better Fuel Performance and Economy discusses the causes and effects of sludge in fuel oil supplies and soot deposits in combustion areas. Shows how these troubles can be eliminated economically, dependably, and permanently with time-tested special Western formulas.

Also, Technical Bulletins on the chemical treatment of potable and plant water supply—refrigerating brine—sweet water systems. Also, the use of Dry Acid Scale Removers.

Whatever your water, steam or fuel treatment problem may be, you can rely on special Western formulas and individual technical service to solve it dependably and economically.

WESTERN CHEMICAL COMPANY

717 Washington Street Kansas City 5, Missouri

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meter relay designed to show signal leve' even while control circuits are energized. Successive circuit stages involved in operation of the new design are illustrated. Assembly Products, Inc.

INSULATION

152 Industrial Insulations — Industrial insulations and insulating cements for power, chemical, petroleum, petrochemical and manufacturing industries are described in Form 6451. Selection guide indicates applications for high temperature and superheated surfaces; high, medium and low pressure steam lines; cold water pipes; heating and air-conditioning ducts; and breechings. The Philip Carey Mfg. Co.

153 Insulation Specifications — This 50-pp manual of specifications, IN-128A, is designed for the power, chemical and petroleum industries. It is divided into five sections — insulations for temperatures above 100 F; those for temperatures below 100 F; tank insulation; sphere and spheroid insulation; regenerator, catalytic reactor and oil heater lining and insulation. Tables include recommended thicknesses for both steam generating plants and process equipment based on average economic conditions for the industries and recommended thicknesses of insulation to prevent sweating. Johns-Manville.

WELDING

154 Gas-Shielded Welding — The story of automatic and semi-automatic CO_2-shielded welding processes is presented in 16-pp Bulletin MW-253. Charts outline typical applications, as well as such data as wire diameters, amperages, voltages, travel speeds, weld positions, and deposition rates, and physical and chemical properties. A. O. Smith Corp.

155 Which Welding Power Source? — This 8-pp article offers a comprehensive guide to proper selection of arc welders for use with stick electrode, gas shielded tungsten-arc or gas-shielded metal-arc welding processes. Illustrated with schematic drawings, it details eight specific steps to be taken into account when choosing one of four basic types of power sources. Air Reduction Sales Co., Div. Air Reduction Co., Inc.

156 Welding Cable Connections — Described in 12-pp Twecolog 12 are arc welding cable connections and accessories. Tables giving specifications and prices are included. Photos illustrate various types of clamps, electrode holders, cable connectors, terminal connectors, and other equipment. Tweco Products, Inc.

MATERIALS HANDLING

157 Sectional Belt Conveyors — Book 2779 is a 40 pp practical handbook on use and selection of standardized sectional belt conveyors. Lists components and accessories and includes detailed engineering and selection data, as well as illustrations showing applications in a variety of industries, and drawings of typical layouts. Link-Belt Co.

158 Big Capacity Shovels — Operating, performance and maintenance advantages offered by 3- and 4-cubic yard tractor shovels with torque converter drive are described in 8-pp Catalog MS-1274.

Decision made 21 years ago proved to be the right one

Garnett, Kansas Light Plant in 1938, selected Standard Oil diesel lubricant

Situation: In 1938, when Garnett, Kansas put two diesel engines (one 600 hp and one 1000 hp) into service, plant management selected a Standard Oil diesel lubricant. In 1948, when a 1400 hp engine was added, the performance from the Standard lubricant caused management to make the same choice. In 1955, when a 2100 hp duel fuel unit was placed in service, STANODIESEL Oil M was chosen.

What has happened: At the Garnett plant, stuck rings and dirty pistons are unknown. The 1400 hp unit was in service nine years before reringing. Overhauls are made only every five years. The top performance from STANODIESEL Oil M and the technical service provided by lubrication specialist, J. D. Jenkins, have made possible first rate, uninterrupted, low cost electric service.

What you can do: The Standard Oil salesman near you in any of the 15 Midwest or Rocky Mountain states has the full story about STANODIESEL Oil M, and how it will perform for you. Call him. Or write, **Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Illinois.**

You expect more from **STANDARD** *and you get it!*

Quick facts about
STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by the use of economy fuels.
- Maintains film on difficult-to-lubricate parts.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil mix.

Garnett plant superintendent John Watkins (left) and Standard Oil's J. D. Jenkins inspect light plant's 2100 hp unit lubricated with STANODIESEL Oil M. Jake Jenkins knows what he's talking about when he advises customers on lubrication. He's been doing this work for 13 years. He has an engineering degree from Missouri School of Mines, and he has completed the Standard Oil Sales Engineering School.

MAINTENANCE CUT 90%

ACE Rubber-Lined Ash Pipe

. . . saves 20 days a year turning and patching pipe at New Haven Railroad's Cos Cob Power Plant

Cinders and fly-ash pouring down this 300-ft. long pipe from the ash handling system of the New Haven Railroad's main power plant quickly scoured holes in cast iron pipe. To save trouble, the heavy pipe was rotated ⅛th of a turn every three months, a few sections at a time. The job took five days.

Then Ace rubber-lined pipe was installed. Its remarkable abrasion resistance kept it in service for three years before turning! Even then, its light weight made it possible to turn 200 ft. at once, finishing the job in one day instead of five.

Ace pipe, lined with rubber developed especially for ash systems, offers *you* these savings too. It's one of *nine* types of Ace plastic and rubber pipe made for tough jobs.

AT LAST! A PERMANENT CURE FOR CONDENSATE RETURN LINE CORROSION

Extensive tests show Ace Tempron pipe... rigid, heat-resistant nitrile hard rubber ...is immune to hot, corrosive steam condensate. Ask about it.

AMERICAN HARD RUBBER COMPANY
Division of Amerace Corporation
ACE ROAD · BUTLER, NEW JERSEY

ACE

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Text matter discussing the features of both units is complemented by many illustrations. Specifications are included. Allis-Chalmers Mfg. Co.

OTHER EQUIPMENT

159 Corrosion Control Tips — Control of water problems in air conditioning system — scale formation and slime and algae growths — is discussed in Bulletin 596. Offers suggestions for the control of these problems through adequate, planned chemical treatment. Application information as well as control testing data are included. Betz Laboratories, Inc.

160 Product Guide — Featured in 68-pp Condensed Catalog 596 is a line of materials handling equipment, parts handling equipment, power rectification equipment, mechanical shaft seals, paper joggers and portable power tools. Presents descriptions, data and specification on all products, and includes photos showing equipment in operation. Syntron Co.

. . . Outstanding Among This Month's Catalogs

161 Refrigerated Purging Guide — Twelve-pp Bulletin 700 gives helpful data on automatic removal of air from refrigeration systems. It answers such questions as why purging is necessary, how non-condensible gases affect efficiency, methods of purging, where to make purge connections and how to use the refrigerated purger. Armstrong Machine Works.

162 Hydrostatic Instruments — This 88-pp pocket-size handbook of hydrostatic instrumentation includes information on principles of hydrostatic measurement, selection and installation of instruments, design and construction of panel systems, as well as engineering data and diagrams. Provides tank volume formulae, conversion tables, viscosity charts, hydrometer scales, specific gravity tables for various liquids, and other pertinent information. Petrometer Corp.

163 Metal Packing — Comprehensive data for selection, application and installation of metal packings for pumps, engines and compressors is presented in 24-pp Bulletin AD-166. Six sections of the bulletin cover free-floating metal packing, metal rod packing rings, metal scraper rings, metallic or non-floating packing and piston rings, and testing and service facilities. The Garlock Packing Co.

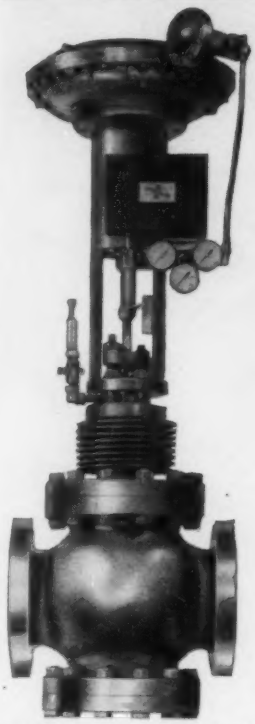
164 Boiler Water Control Unit — Described in this 6-pp bulletin is an automatic side-stream boiler water control system designed to keep boiler water clear. Explains how system works to minimize suspended solids, afford other advantages. One unit installation, compactness, versatility, operating economy and other benefits detailed. Sparkler-Filtrion Corp.

165 All-Weather Lubricant — An all-weather, open-gear lubricant for outdoor equipment is featured in this 16-pp booklet. Listed are various grades and consistencies containing either colloidal

COPES VULCAN

BLAW-KNOX

How Copes-Vulcan control systems boost power plant efficiency



Type CV-D (diaphragm-operated) valve serves a broad variety of applications in sizes up to 12 inch. Optional features include: cooling fins and stuffing-box lubricator to maintain low friction over long packing life, auto-lock, top or side-mounted handwheel for emergency operation.

Valves used in modern combustion control system. One diaphragm-operated valve is used as a single-seated fuel return control valve (left) while another controls the speed of the turbine driving the forced-draft fan (right).

Efficient feedwater-flow control system uses a Type CV-D valve equipped with positioner, air lock, and emergency handwheel operator (left). Another diaphragm-operated valve trips automatically if fuel-oil line pressure drops below a safe limit (right).

Copes-Vulcan Regulator Valves bring precision control to exacting jobs...

Designed for superior accuracy and long range dependability, Copes-Vulcan valves establish new standards of efficiency for pressure, temperature, flow, and level control.

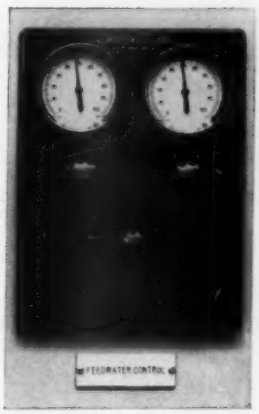
To assure trouble-free performance, Copes-Vulcan custom designs each valve to suit your most rigid control requirements. The kind of fluid—its flow, pressure, and temperature—are all studied before a recommendation is made. Port area and style are selected on the basis of careful research.

The Copes-Vulcan line includes the following valves.

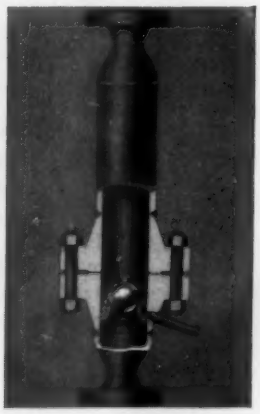
Diaphragm valves (Type CV-D) provide greater versatility . . . have excellent rangeability . . . may be direct or reverse acting.

Piston-type valves (Type CV-P) offer simplicity of design . . . ideal where valve-operating force must be unusually high, where positioning must be precise.

Nuclear valves for ships, atomic plants, and test reactors. Supplying valves for these advanced projects offers proof of the acceptance of Copes-Vulcan's skill and integrity.



Pneumatic control stations assure combustion control efficiency. Copes-Vulcan stations offer simple automatic-to-manual selection without complication of seal balance. Transfer is "bumpless" without process disturbance. Write for Bulletin 1031.



Desuperheater improves temperature control. New Copes-Vulcan Variable-Orifice Desuperheater holds reduced steam temperature constant less than twenty feet downstream from desuperheater outlet, even over a 50-1 load range. Write for Bulletin 1037.

Copes-Vulcan Division
BLAW-KNOX COMPANY
Erie 4, Pennsylvania

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ROTOJET®

Cleans TUBES and PIPES

ANY SIZE

from ½" to 12" I.D.

STRAIGHT or CURVED

Roto engineers are constantly designing new equipment to meet new conditions and applications for its tube cleaners. If you have a pipe or tube cleaning problem, we will be pleased to place our long specialized experience at your disposal. Write, wire or

Phone HUmboldt 3-0570

Illustrated are a few of the many types and sizes of Rotojet Tube Cleaners driven by air, steam or water. We analyze each application before recommending equipment that best meets the requirement.

ELLIOTT COMPANY – ROTO PLANT

Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

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graphite, colloidal molybdenum or non-graphited grades, and grade recommendations for outdoor equipment including bearings, cables and wire ropes, dipper sticks, gears and track rollers. Acheson Colloids Co.

166 Heat Transfer Cements — Properties and uses of heat transfer cements for external heating and cooling applications are detailed in Engineering Data Book 502. In addition to general information on properties and advantages of the cement, it includes engineering data and calculations, estimating and installation data. Thermon Mfg. Co.

167 Air Dehumidifier — Bulletin 140 describes an apparatus using a liquid absorbent for drying air to control its properties for industrial processing and product drying at low temperatures and the air conditioning of spaces for packaging and storage of moisture sensitive materials. Operating and control details illustrated on diagram. The Niagara Blower Co.

168 Propeller Fans — Self-cooled motor propeller fans designed to meet exacting application requirements are featured in 20-pp Catalog 159. Includes section on selection of proper fan to suit ventilation requirements of area and describes various types of fans for these applications, as well as giving complete specifications. Ilg Electric Ventilating Co.

169 Electrical Resins — Two methods of encapsulating re-wound electrical motors in epoxy resin are presented in step-by-step procedure in this brochure. Illustrates and describes the no-mold process and the molding process. Minnesota Mining and Mfg. Co.

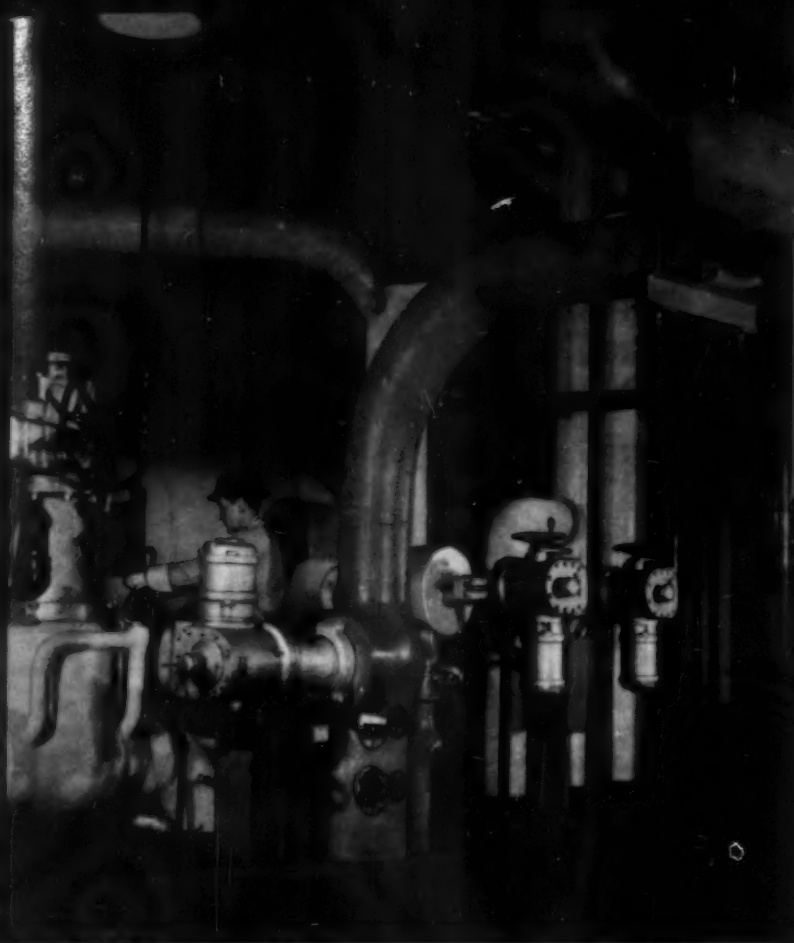
170 Tapered Tower — Advantages of design and operation of company's cooling tower with tapered collecting pan and central depressed sump are detailed in Bulletin 51-902. Capacity tables and suggested specifications are included. J. F. Pritchard & Co.

171 For Automatic Boilers — This 6-pp folder features a mechanical pressure atomizing oil and nozzle-mix gas burner for automatic boilers. Drawings illustrate construction features and operation principle. Boiler Engineering & Supply Co., Inc.

172 Hinged Closures — Hinged closures with built-in safety features for vacuum, low and high pressure service in petroleum, chemical and other industries are described in Bulletin TT956-5-659. Photos illustrate one-weld installation, easy maintenance and one-man operation — charts give dimensional specifications and cross-sectional drawings give design features of various sizes and types. Tube Turns Div. of Chemetron Corp.

173 Filter Media Selection — Twelve-pp Bulletin PUR-66D contains a chart designed to guide selection of proper engineering materials and filter media for given types of corrosive conditions. The chart lists filter media for varying concentrations of more than 125 corrosive agents. Purolator Products, Inc.

174 Tube Fittings — Featured in 20-pp Form 259 is a line of tube fittings and accessories, including hydraulic tube fittings, straight thread fittings, flare tube fittings, and hydraulic accessories. Photos and specifications are included, as well as cutaways and drawings. Lenz Co.



POWER: "Where steam is so hot it makes piping glow . . . velocity so great it would 'chew out' ordinary valves trying to hold it"

CRANE PRESSURE-SEAL BONNET VALVES

Pressure-Seal Bonnet Gates

This is the place for

CRANE

PRESSURE-SEAL BONNET VALVES

LIP-SEAL BONNET VALVES

—the modern valves for high-pressure / high-temperature services

Lip-Seal Bonnet Globes and Angles

Since 1855 — Crane Co., General Offices: Chicago 5, Ill.
Branches and Wholesalers Serving All Areas

CRANE Pressure-Seal Bonnet

Y-PATTERN GLOBE AND ANGLE VALVES

900-, 1500-, and 2500-Pound

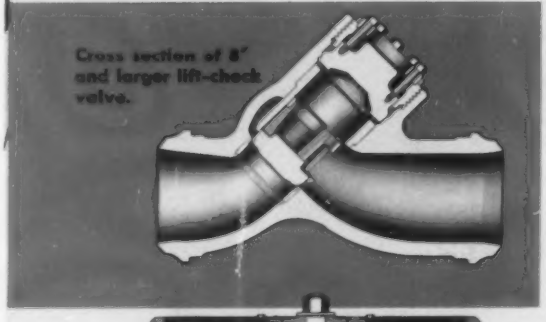
These valves give you all the advantages of the modern Crane pressure-seal bonnet principle as detailed for the gate valves shown opposite. Available in socket- and butt-welding ends.

Cost-cutting features

- Disc and seating surface *Stellite*-faced.
- Integral yoke and bonnet retaining ring, screwed into body in smaller sizes, clamp ring construction in larger sizes —maintain rigid alignment of body, stem and bonnet.
- Stainless steel inlay in body insures positive seal ring seating.
- Cast Y-pattern body, with smooth interior surfaces, contoured for minimum turbulence and pressure drop.
- Two-piece, ball-type packing gland can't bind stem.

NEW CHECK VALVES—HORIZONTAL GLOBE LIFT-CHECK DESIGN

900-, 1500-, and 2500-Pound



Unique Crane design. Y-pattern body combines with Crane cage-type body liner construction to permit maximum flow with minimum pressure drop—without resorting to oversize seat opening. Piston-type disc and liner are the only internal parts. Crane design prevents entrapment of fluid above disc—insures proper disc operation.

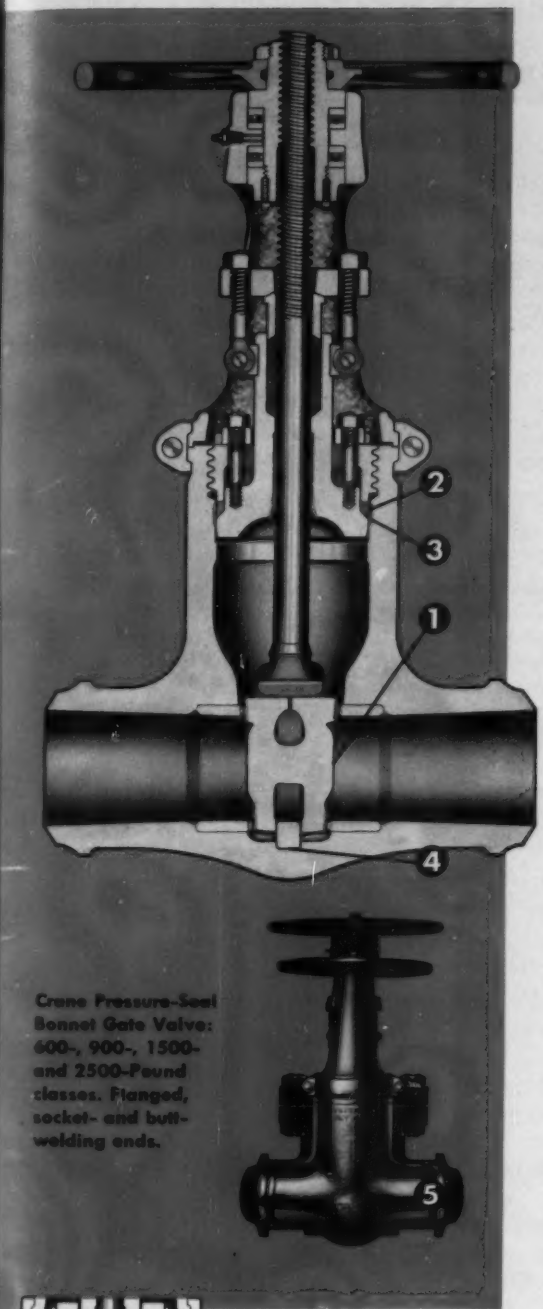
STOP-[illegible] CHECK VALVES—GLOBE AND ANGLE PATTERNS

900- and 1500-Pound

- Direct yoke-to-bonnet mounting—holds all parts in rigid alignment. Yoke swivels to any position for mounting valve operator.
- Stainless steel inlay in body insures positive seal ring seating.
- Two-piece, ball-type packing gland prevents stem binding.
- Easy to dismantle.
- No bonnet joint maintenance.
- *Stellite*-faced body seat ring is seal-welded in body—will not loosen in service.

Valves for all modern power control

CRANE PRESSURE-SEAL BONNET VALVES



Crane Pressure-Seal Bonnet Gate Valve: 600-, 900-, 1500- and 2500-Pound classes. Flanged, socket- and butt-welding ends.

GATE VALVES

600-, 900-, 1500- and 2500-Pound

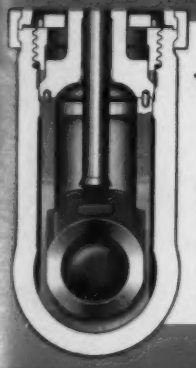
Here is the most modern valve designed for high-pressure/high-temperature service. Bonnet joint leakage is eliminated. Weight is reduced without sacrificing strength or safety. Its streamlined contour simplifies insulation. Special metals protect critical points of wear. No wonder it is the number one choice of power stations for trouble-free, minimum-maintenance service.

Note these features

1. Flexible wedge disc prevents sticking when valve is closed hot and opened cold—doesn't jam even when seated with excessive torque.
2. One-piece, silver-plated seal ring—secured by chrome-plated retaining ring screwed into the body—remains freeze-free for easy dismantling.
3. Wear-resistant stainless steel inlay in body insures tight sealing and maximum protection against corrosion.
4. Full-travel disc guiding to point of final closure—prevents wear and drag on seating surfaces.
5. Streamlined, weight-saving design saves up to 60% of weight of bolted bonnet valves—reduces suspension cost; simplifies insulation.

All Crane Pressure-Seal Bonnet Valves are ASA-rated.

Minimum metal thicknesses comply fully with the requirements of ASA B16.5-1957, as well as ASA Code for Pressure Piping and ASME Boiler and Pressure Vessel Code.

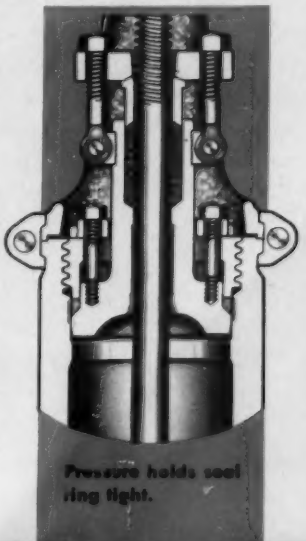


Tee-head disc-stem connection

Ample clearance between the head on the stem and the slot in the disc prevents side strains on the stem. Stem is only required to move the disc—not to serve as a guide.

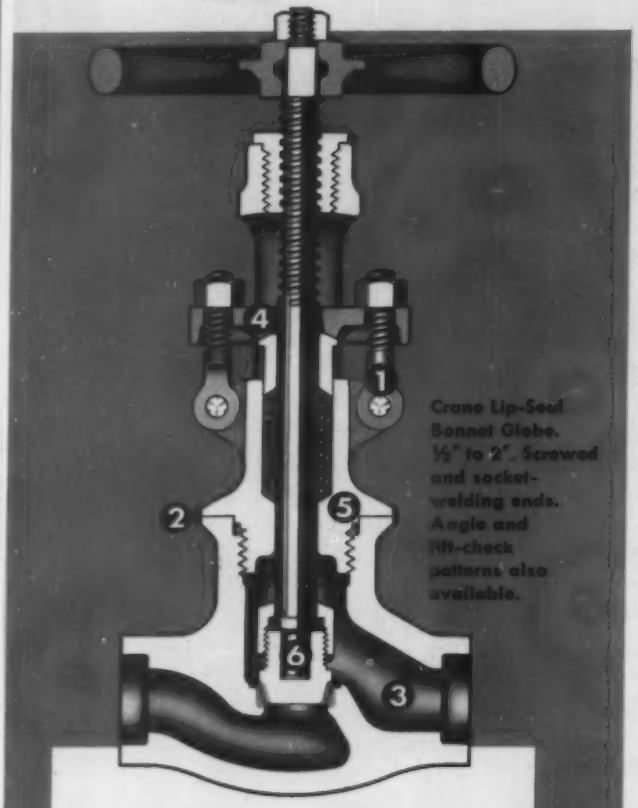
HOW PRESSURE SEAL IS MADE

Line pressure, acting upon the entire underside of the bonnet, forces it against the seal ring. The seal ring wedges between body and bonnet, forming a pressure-tight, metal-to-metal joint. The higher the pressure, the tighter the seal. Bonnet joint maintenance is eliminated. Except for minor modifications, the same pressure-seal principle is used on all types and sizes of Crane pressure-seal bonnet valves.



Pressure holds seal ring tight.

CRANE® Lip-Seal Bonnet Globe Valves



Crane Lip-Seal Bonnet Globe. ½" to 2". Screwed and socket-welding ends. Angle and lift-check patterns also available.

Crane quality features

1 Stainless steel eyebolts—prevent corrosion.

2 Welded bonnet joint lip-seal—eliminates bonnet joint maintenance, carries no mechanical load. Permits convenient grind-off, easy rewelding.

3 Compact design—no sacrifice of strength or size of port area.

4 Two-piece, ball-type packing gland—prevents binding on stem.

5 Body-centering lip—assures perfect body-bonnet alignment.

6 Improved disc-stem connection—assures positive closure and minimum vibration without hampering swivel action of disc.

3 PRESSURE CLASSES

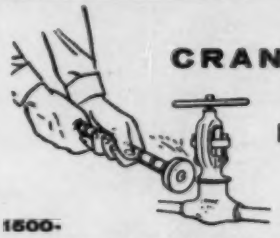
1500-Pound ASA – in carbon steel (WCB); 1570 psi, 1050 F (2500-Pound ASA) – in Crane No. 7 chrome-moly (WC6); 2520 psi, 1050 F – in Crane No. 7 chrome-moly (WC6).

Performance-proved in hundreds of power plants, these compact, tight-sealing valves are widely used on boiler feeds, blowdowns, drips and drains, bypasses, and similar applications.

Well-proportioned, cast valve bodies with specially shaped interiors provide smooth flow—minimize turbulence and disc vibration. Plug-type disc and seat are *Stellite*-faced to reduce wear. Stem and disc are fully guided for positive seating. Bonnet threads are chrome-plated to prevent galling and seizing. With weld removed, bonnet screws out . . . makes inside of valve easily accessible.

All Crane Lip-Seal Bonnet Valves are ASA-rated

Minimum metal thicknesses comply fully with the requirements of ASA B16.5-1957 as well as ASA Code for Pressure Piping and ASME Boiler and Pressure Vessel Code.



CRANE LIP-SEAL BONNET LIFT-CHECK VALVES

1500-Pound; 1570 psi, 1050 F

Available with screwed or socket-welding ends. ½" to 2". High disc lift assures free flow and minimum pressure drop. Offers all the advantages of Crane exclusive Lip-Seal weld design: elimination of bonnet joint maintenance . . . easy dismantling and reassembly . . . chrome-plated bonnet threads that prevent galling and seizing.

CRANE® VALVES & FITTINGS

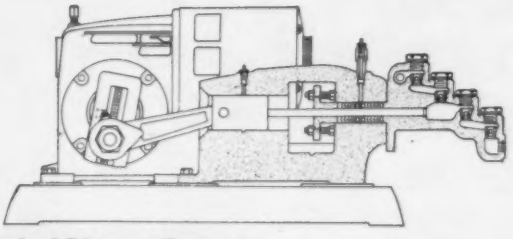
PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855 — Crane Co., General Offices: Chicago 5, Ill. — Branches and Wholesalers Serving All Areas

HOW TO METER ACIDS ACCURATELY AGAINST PRESSURE

Corrosive liquids present two major obstacles to achieving maximum metering accuracy, economy, and safety. For one thing, corrosion can introduce an intolerable ever-changing volumetric error. For another, corrosive liquids must be retained by the pump at all times. Leakage can endanger personnel and necessitate the premature replacement of pump parts and associated equipment.

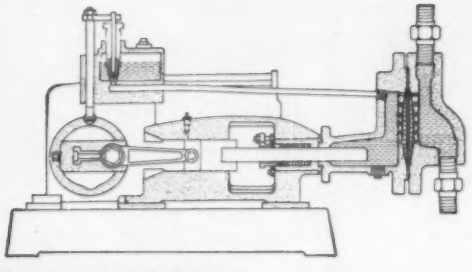
But both obstacles can be successfully overcome. First by choosing the right pump for the metering job at hand. Second, by making sure that all wetted parts of the pump chosen are inert to the liquid being metered. Here are some ideas based on practical acid metering experience that may help you to choose the one best controlled volume pump for your metering needs.



Packed Plunger Pumps

For the majority of mildly corrosive liquids, low cost packed plunger pumps have proved themselves entirely adequate. Some thirteen materials of construction are *standard* on packed plunger pumps, running from cast iron to Hastelloy B and C, more than enough to satisfy mild corrosive metering requirements. Capacities to 2056 gph, pressures up to 50,000 psi.

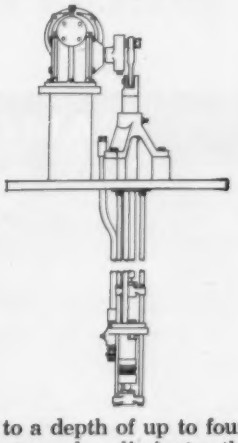
An added tip: Standard Milton Roy motor driven pumps in corrosive service can be equipped with "catch-all" yoke type gland followers.



Diaphragm Liquid Ends

When the liquid to be metered is highly corrosive or otherwise dangerous, a controlled volume pump with diaphragm liquid end is the best choice. A plastic or stainless steel diaphragm positively separates the process liquid and the plunger. The plunger displaces a hydraulic fluid which in turn strokes the diaphragm to create pumping action through the ball checks. Consistently high accuracy is achieved through unique design features. As the illustration shows, positive mechanical action bleeds any air or vapor from the hydraulic side between strokes and corrects liquid volume if necessary. Internal liquid end design also automatically eliminates bubbles from the process liquid side.

Very often, a pump chosen for mild corrosive service is obsoleted by a process change specifying a more highly corrosive liquid. But this waste is neither necessary nor desirable. The diaphragm liquid end illustrated can easily be substituted for the conventional liquid end on any standard motor driven controlled volume pump, bringing the entire metering system up to date at little extra expense. *Designs of this type will handle up to 400 gph against heads to 2700 psi.*



Totally Immersed Liquid Ends

Special metering problems demand special pump designs. For example, acids with high vapor pressure or high specific gravity must be pumped with limited suction lifts and generally require suction heads. The ideal answer is the standard Mersemetric® controlled volume pump. Pump drive and motor are mounted on the tank top, but the liquid end is completely submerged to a depth of up to fourteen feet. This same design feature also eliminates the need for tank connections below liquid level, and permits chemicals to be metered *directly* from storage.

The maximum safety-minimum handling Mersemetric design is just about standard for metering sulfuric acid for demineralizer regeneration and pH control of cooling tower water and deaerator effluents. *Capacities up to 218 gph, pressures up to 1200 psi.*

The Acid Metering System

You can be fairly sure of making the right choice only if you consider *all* the factors. Here's a convenient checklist of a few points that are often overlooked:

- Is the entire *system* corrosion-resistant . . . storage tank, suction and discharge piping, controlled volume pump, and relief valve?
- Have you thoroughly considered the physical properties of the liquid? High vapor pressure or high specific gravity liquids may demand a suction head.
- Have you considered plant and personnel safety under all possible conditions?
- Have you considered maintenance as well as first cost in determining the economics of the system?

If precision pumping of dangerous chemicals is one of your problems, look again to Milton Roy's 25 years of experience for your most economical solution. Write for a general introduction to controlled volume pumping in Bulletin 553-1. Milton Roy Company, 1300 East Mermaid Lane, Phila. 18, Pa.

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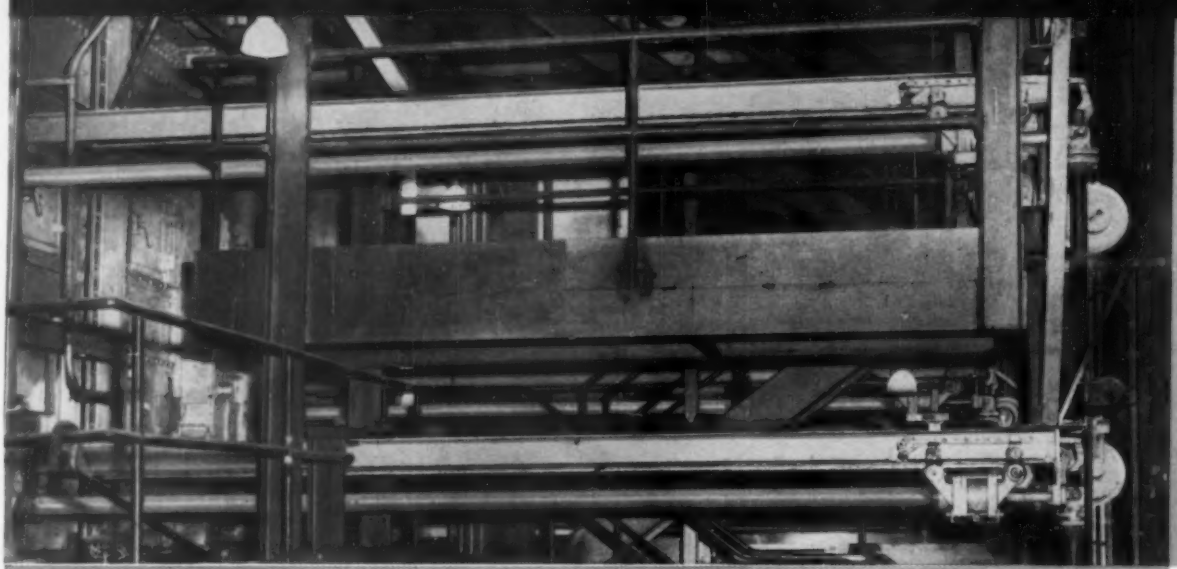
SAVE $40,000

DIAMOND BLOWERS and AUTOMATIC



Three of the Diamond Model IK Long Retracting Blowers installed to replace manually operated rotary blowers. Electric motor driven, they are controlled by the Automatic Sequential Panel. Air is used as the blowing medium. Rotary elements were retained in cooler locations and motorized for automatic operation and are also controlled by the Automatic Sequential Panel.

In the continuous struggle to cut operating costs, the Dayton Power & Light Co. has found a very useful tool in "Boiler Cleaning Modernization."

By applying the latest soot blowing equipment to four of their boilers at the F. M. Tait Station, together with other features of the modernization program, the Dayton Power & Light Co. was able to reduce the operating costs on these boilers by some $40,000 per year and also cut blower maintenance costs.

On the first boiler that had its cleaning modernized, 17 rotating elements were removed; the remaining seven blowers of this type were electrified for automatic control. The cleaning equipment added consisted of five Long Retracting Blowers and six Short Retracting Blowers. All blowers are automatically controlled by a Diamond Selectromatic Panel.

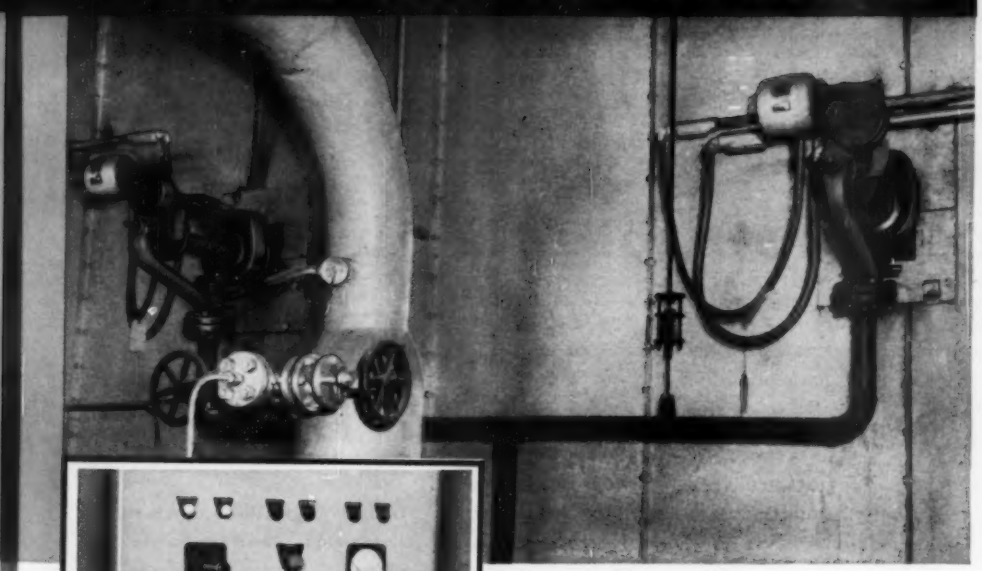
This is one of many examples of the savings possible by improvements now available in Diamond Blowers and Automatic Sequential Control. Over the years Diamond has engaged in continuous aggressive research in boiler cleaning. This research has paid off in improvements that save you money and improve your operation.

Let us make a study of your boiler cleaning . . . perhaps similar savings can be suggested.

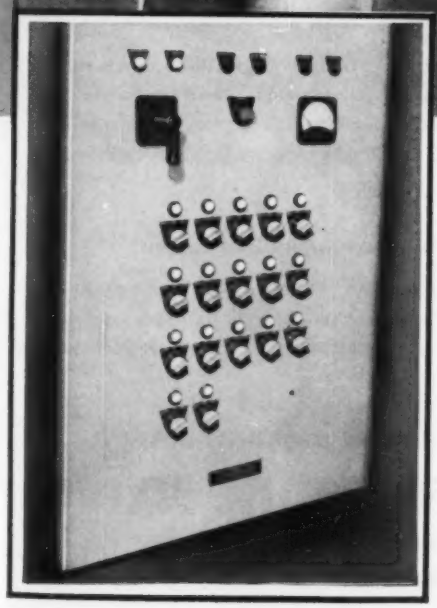
Per Year in Operation

and Cut Blower Maintenance Costs

SEQUENTIAL CONTROL PANEL



Two of the air blowing Model IR short retracting wall blowers with electric automatic operation.



Diamond Automatic Sequential Control Panel installed as part of the modernization program at the F. M. Tait Station. This panel automatically operates each blower in turn until the blowing cycle is complete. Any individual blower may be operated independently by simple turning switches. Cleaning program is set up by switches. Operator starts — thenceforth operation is automatic.

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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developments in the field of Nuclear Power throughout the world

ANDREW W. KRAMER
Editor

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There are some key concepts in nuclear engineering which are particularly confusing to power engineers. One of these is the hot channel concept used in the design of water cooled reactors. In this article Mr. Rubinstein, who is nuclear engineer at the Dept. of Water and Power, the City of Los Angeles, explains this important concept simply and clearly.

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OUT OF THE REALM OF FANTASY

After many years of more or less useless discussion of the question of nuclear power costs, the time finally seems to be arriving when we can begin to emerge from the realm of pure fantasy into the world of hard facts with respect to power costs. As long as no nuclear power plants had been built any attempt to discuss power costs was colored by the individual prejudices of those making the estimates. The enthusiasts and the proponents of nuclear power produced rosy pictures of 6 and 7 mills per kilowatthour, while the die-hards—those who predicted nuclear power to be many decades away—talked of 25 to 40 mills per kilowatthour costs.

There are still not too many nuclear plants in operation but enough have reached stages in their construction where it becomes possible to form some realistic appraisal of what power costs of these plants will be. A recent report released by the Atomic Energy Commission (See New Nuclear Literature, this issue) presents data on the cost of electricity from plants presently in operation, being built, or planned for early construction. These plants involve the use of either pressurized water or boiling water reactors with net capacities of 150 electrical megawatts or more.

It is of interest to know that the average total power costs for these plants ranges from 11 to 18 mills per kilowatthour. By far the largest single factor in the cost of electricity from these plants is the high fixed charges arising from the high capital investment. These range from 6.5 to 10 mills per kwh. As indicated in the report, this effect may be somewhat reduced if the plants can operate above their design power levels. Where a utility system can justify the installation of a nuclear plant having a design capacity considerably above 150 mw(e) the fixed charges per kilowatthour should be significantly less than those given above. Fuel cycle costs also are high and these could be reduced if some way could be found to reduce fuel element fabrication costs. This is a profitable area for research and development. One of the factors that would reduce fuel fabrication costs would be simplification of design and relaxation of the rigid specifications that now prevail. In view of the physical changes that take place as a result of both neutron flux and thermal exposure, it is questionable whether the extremely close tolerances that are now used in manufacture are really necessary.

While it is obvious from the AEC report on power costs that nuclear plants are not yet competitive with costs for conventional plants either in the U. S. or generally in the Euratom countries, the figures presented are encouraging and in some areas at least point the way to further reduction.

Andrew W. Kramer

The hot channel concept as applied to nuclear reactors has been a source of confusion to many interested in water cooled reactors. To remedy this situation, in this article, the author endeavors to clarify the meaning of such terms as peaking factors, burnout flux, and burnout safety factors. The discussion should be of particular interest to power engineers who are not intimately involved with reactor design but need an understanding of the terminology and design parameters used.

The Hot Channel Concept of Water Cooled Reactors

By H. J. RUBINSTEIN

Nuclear Engineer

Department of Water and Power, City of Los Angeles, California

ONE of the most interesting and important engineering problems in the design and operation of nuclear power reactors is that which concerns heat removal. From purely nuclear considerations, the reactor can generate any amount of thermal power one wishes. The only limit to this is the ability to remove the heat without reaching excessive fuel element temperatures. A nuclear reactor contains all the fuel that it may require for weeks or months or even years. Thus, the rate of power generation is not dependent upon the rate of fuel feed as is the case in ordinary steam boilers.

Basically, the equation which determines the power rise of a nuclear reactor is given by the following equation:

$$P = P_o \epsilon^{\left(\frac{\Delta k t}{l}\right)}$$

where P_o is the initial steady state power, Δk is the reactivity added, t is the time, and l is the value of neutron generation time between successive neutron births. It is evident that one only need add a Δk, and the power will go up exponentially until some other phenomenon, such as the negative temperature coefficient or void production, adds a negative reactivity which cancels the original Δk.

Thus, in a nuclear reactor we have a device which can produce any desirable amount of power at any rate. Under experimental conditions, during brief intervals, the power level of reactors has risen from zero to many millions of kilowats in a small fraction of a second. In practice, where do we stop? This is the problem the heat transfer engineers have to meet.

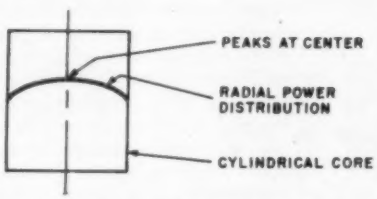
Because of the absolute safety required in the operation of nuclear power reactors, and the difficulty of core maintenance, the heat transfer engineers have developed the concept of the "hot channel" within the core. In plain words, this is the region in the core where things are at their worst.

The hot channel is a hypothetical channel within the reactor core where all factors which promote heat generation are at their maximum and all factors which promote heat removal are at a minimum.

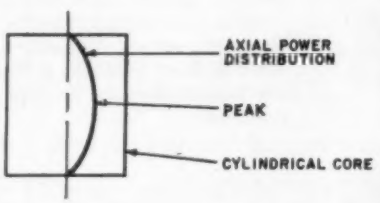
A list of some of these factors might be presented as follows:

Nuclear Factors

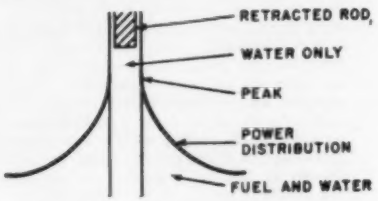
1. The radial thermal neutron flux across the core generally peaks in the center of the core. Since thermal power is proportional to neutron flux, the power or heat generation will also peak at the center as shown in this sketch below.



2. The longitudinal or axial power distribution will also peak according to a similar pattern. Here, as shown below, the flux peaks at the center of the core.



3. When a large gap appears in a core, such as one left by removing control rods, there is an area where neutrons are thermalized faster than in other core areas. This is called "water gap peaking" or water hole peaking. A water gap may cause peaking like this:



Since there is generally fuel in the neighborhood of the gap, there is also a power peaking.

All of these conditions are called nuclear peaking factors because they are all due to neutron flux peaking.

Mechanical Factors

In addition to the factors described above, there are also the so-called "mechanical factors" which can cause temperature peaking. These are due to the mechanical aspects of the design. Some of these are:

1. Fuel enrichment cannot be made exactly uniform during manufacturing. The tolerance of enrichment, thickness or density of metal or UO_2 make it probable that there will be some regions or spots in the reactor where the fuel density will be higher than that of the surrounding areas. Since power is a function of the number of U-235 atoms/cm³ times the neutron flux, the power will increase in this hot spot area.

2. The eccentricity of the clad material or changes in the conductiv-

Table I Nuclear Factors

Nuclear	Typical Values
Radial (F_r)	1.25
Axial (F_a)	2.00
Water hole (F_{wh})	1.30

Product of nuclear factors (F_n) = 3.25

Table II Mechanical Factors

Mechanical Factors Applied To:	Flux	Film Drop	Water Rise
Fuel concentration & thickness	1.18	1.18	1.12
Eccentricity	1.14	1.14	1.05
Flow distribution	1.00	1.06	1.07
Heat transfer uncertainties	1.00	1.25	1.00
Product of mechanical factors	1.34	1.78	1.26
Symbol	$F_{m\phi}$	$F_{m\theta}$	$F_{m\Delta T}$

ity of the metal may cause a low resistance heat path and cause a hot spot. Here again manufacturing tolerances come into play. We do not want to restrict the manufacturer too closely on this, or on Item 1, above, because fuel fabrication costs will increase if we do.

3. If tolerances in core assembly exist, then we will have some coolant flow channels within the core with a somewhat lower mass flow and velocity. This reduces the heat transfer ability in that channel and causes another hot spot. Coolant flow variations may also be caused by unfavorable inlet pelnum conditions, or by factors which would cause an additional pressure drop such as steam generation. Also, fuel warpage could reduce flow in a channel.

4. Uncertainties in the heat transfer calculations are also a cause for concern. The equations that predict heat transfer coefficients, the physical properties of the coolant and metal are only correct within certain tolerances. If they are wrong for a number of these, we may be causing a hypothetical hot spot by assuming that the heat transfer characteristics of the reactor are better than they really are.

Now here is where the real conservatism creeps into the design. Most reactor designers assume that all these hot spots occur in the same channel of the core. In other words, all the possible tolerances coincide at their worst in the one unfortunate "hot channel" of the core.

A summary of typical nuclear and mechanical factors which would be applied for heat flux peaking are as follows:

It is seen that different sets of mechanical factors apply to the equations which predict peak flux, channel water temperature rise, and surface film temperature drop. These are called $F_{m\phi}$, $F_{m\theta}$, and $F_{m\Delta T}$.

For the above hypothetical core, the net peak flux to average flux would be $F_p = F_r \times F_a \times F_{wh} \times F_{m\phi} = 1.25 \times 2.0 \times 1.3 \times 1.34 = 4.36$.

The average core heat flux in Btu/hour/ft^2 is:

$$\left(\frac{q}{A}\right)_{av} = \frac{P \times 3413 \times .92}{A}$$

where P is the maximum thermal power in kw, and A is the core heat transfer area in square feet. The factor .92 is used because it is assumed that only .92 of the fission heat is absorbed in the fuel element. The remaining 8% is released by gamma rays and neutrons and does not appear as heat flux passing through the fuel element.

The peak heat flux in the hot channel is:

$$\left(\frac{q}{A}\right)_{peak} = F_p\left(\frac{q}{A}\right)_{av}$$

In our example, the peak heat flux would be greater than the average by a factor of 4.34. The serious disadvantage of the flux peaking is that we must design our core with a heat transfer surface area which is 4.34 times greater than would be indicated by the average heat flux. We now can see the incentive towards reducing or "flattening" the peaking within the core. Flux flattening may be accomplished by programed control of rod movement or by core geometries which have an inherently flat flux.

Once the maximum heat flux is known, one must decide whether this value is below the maximum allowable heat flux. This maximum allowable flux is called the "burnout heat flux." At burnout the heat flux is so great that the metal surface temperature of the element is considerably higher than the bulk coolant saturation temperature, and steam bubbles form at a very rapid rate. When the steam bubbles become very numerous a condition of steam blanketing is reached. If this occurs, the surface film temperature differential increases until the temperature of the metal reaches its melting point. Burnout usually happens almost instantaneously and without warning; hence, the reactor designers' fear of it is well justified.

A burned-out fuel element means the release of fission products to the coolant circuit, and possible contamination of the various parts of the primary loop.

The burnout flux is a quantity which is usually measured by actual test. In these tests a group or bundle of fuel elements is heated electrically to simulate the nuclear heat generation. The bundle is put in a sort of autoclave, where the physical conditions of flow, temperature and pressure are made as close to the reactor operating values as possible. Under these dynamic conditions the heat generation is increased until burnout is achieved. This is obviously an expensive procedure from the equipment standpoint, since only one point on the burnout curve is achieved by each test. In addition the test section is usually destroyed.

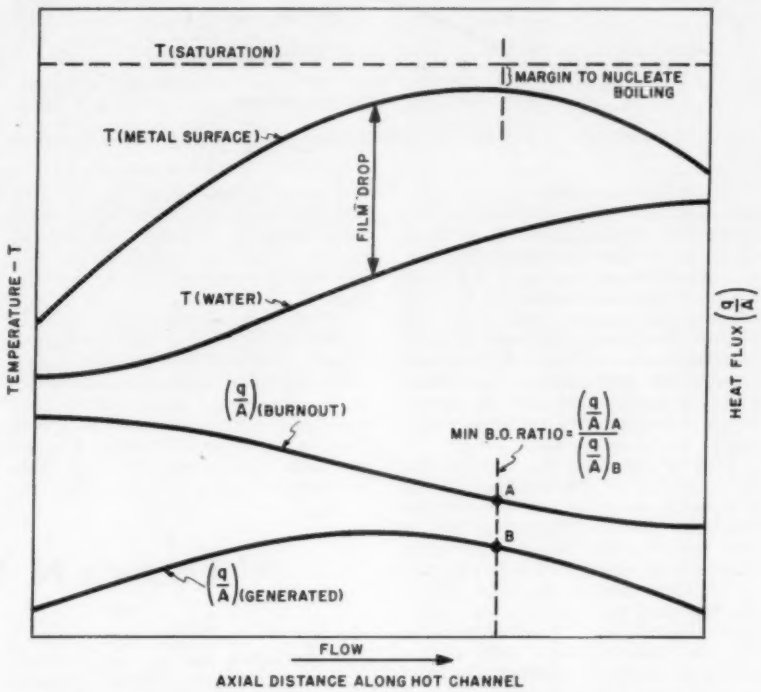


Fig. 1. Temperature and Heat Flux characteristics for Pressurized Water Reactors

ATOMICS

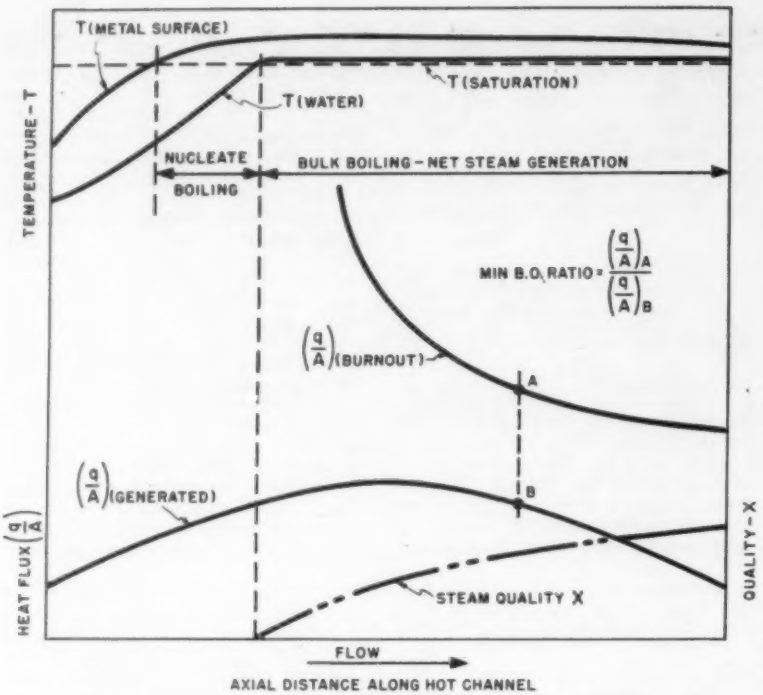


Fig. 2. Temperature and Heat Flux characteristics for Boiling Water Reactors

These burnout tests are necessary for each new kind of fuel element geometry. Correlations have been made to predict the burnout point, but these are only good for a limited range of physical conditions and for a given fuel element geometry. The reason for this is that the burnout mechanism is extremely complex and as yet not fully understood. Much basic research must still be carried out in this area for better understanding of the phenomenon.

Having obtained the burnout flux by tests for an element design, one is now in the position to determine whether the peak flux calculated for the hot channel has a safe value. Here we are concerned with the ratio of burnout flux to the peak flux at the hot spot, and we call it the "burnout safety factor" or sometimes simply the "burnout ratio." For a given hot spot along the channel, the burnout safty factor = $\frac{\text{burnout flux}}{\text{hot spot flux}}$.

Many reactor designers believe that this ratio should be at least two. This would prevent burnout during an abnormal condition such as a power surge or a sudden reduction in coolant flow. Generally a new or "clean" reactor, which is just put on the line, will have a lower burnout ratio than at any other time during its life. As the fuel in the nuclear hot spots becomes used up, the core tends to flatten itself and the burnout ratio increases. This is complicated by the poison build-up during life, and the flow distribution in the core caused by orificing or boiling, and only generalized observations may be made. Many of the overpower experiments which have been widely publicized were made on cores which have had many hours of normal operating conditions and were well "burned out" or self-flattened before the tests were made. Whether these overpower tests could be successfully accomplished on a clean core may be legitimately questioned.

In some reactor designs, though the burnout ratio will be safe, we still might have an undesirable condition of excessive temperature at the center of the fuel element. The ceramic UO_2 element is an example of this possibility, and excess temperatures may be caused by the low conductivity of the ceramic material. The temperature at the center of a typical element would be the coolant temperature at the hot spot, plus the surface film drop, plus the rise across the cladding, plus a rise across a gas-filled gap, plus a rise in the ceramic meat itself. Because the conductivity of the ceramic elements is about one tenth that of the metal elements, temperatures as high as the ceramic melting point of 5000 F may be achieved. If the designer wishes to avoid a molten center, then this may become the limiting criteria. He may have to increase the heat transfer area or make the fuel elements smaller in diameter.

There has in recent months been some feeling that a molten UO_2 center may not be a limit to the design. It is thought that a few elements within the reactor in the hot spot region may be permitted to operate with molten centers. The main disadvantage of this would be the release of locked-in fission gases which may cause an additional pressure on the cladding. The effect, however, may be non-damaging if the fuel element is designed with this event in mind.

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3. Charles F. Bonilla, "Nuclear Engineering" (McGraw Hill Book Co., Inc., New York, 1957)
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Launch N. S. Savannah

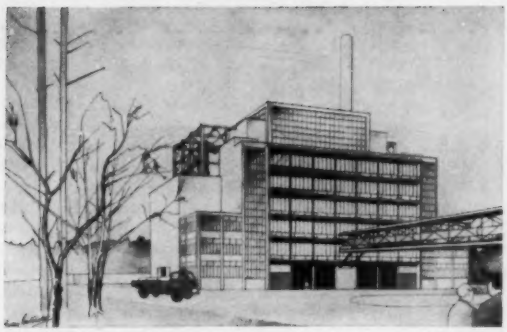
WHEN THE N. S. SAVANNAH slid down the ways at Camden, July 21, one of the first-row spectators was A. W. Kramer, Editor of ATOMICS, and formerly the Editor of POWER ENGINEERING.

Reason Mr. Kramer was there, accompanied by Mrs. Kramer, was that he is currently in the process of writing a book of approximately 600 pages on the subject of commercial nuclear ship propulsion. He was commissioned for this task by the Atomic Energy Commission and the U. S. Maritime Administration. It is to be published early in 1960.

Purpose of the book is very similar to the purposes which inspired the construction of the Savannah, the world's first commercial nuclear-powered ship, to which a substantial portion of the book will be devoted.

N. S. Savannah has five important missions. It will demonstrate to the world the employment of nuclear power in an instrument of peace for the benefit of mankind; it will bring the power of the atom into the market places of the world in peaceful trade and commerce; it will enlighten the public to the fact that nuclear-powered ships are entirely dependable and safe.

Further, it is expected to stimulate early solutions to such problems as international liability and indemnification, and win for nuclear ships acceptance in the world's ports; and it will give the Maritime Administration and the Atomic Energy Commission the opportunity to prudently assess the possible contributions of atomic power to the progress of the American Merchant Marine.



Japan's First Nuclear Power Station

THE GENERAL Electric Company Ltd. of England of Magnet House, Kingsway, London, W.C.2, is to build Japan's first nuclear power station.

In February the Japan Atomic Power Company announced that it had opened exclusive negotiations with G.E.C. for the supply of a 150-mw(e) nuclear station to be built at Tokai Mura, about 70 miles north-east of Tokyo. These negotiations have now been satisfactorily concluded, and a letter of intent has been placed with G.E.C. It is expected that the final details of the contract, the value of which will be approaching £20,000,000 ($56,000,000), will be settled later in the year. The station will take about four years to build and is expected to be in full operation in 1963.

The design of the single-reactor power station was submitted by G.E.C. in collaboration with Simon-Carves, Ltd., Cheadle Heath, Stockport, Cheshire. Of particular interest are the measures taken to ensure the safety of the installation under earthquake conditions.

2000 Fuel Channels

In its basic elements, the reactor is similar to those already being built for the British nuclear power program. The natural uranium fuel elements are mounted in vertical channels through the reactor core, which is built up from interlocking graphite bricks and tiles weighing a total of almost 1500 tons. There are 2056 fuel channels, each containing eight fuel elements. The core is completely enclosed in a spherical pressure vessel having an internal diameter of 62 ft, and this, in turn, is surrounded by a concrete biological shield about 10 ft thick.

The heat generated inside the reactor is extracted by circulating carbon dioxide gas through the core. This gas is heated in its passage over the fuel elements and is then led away through six feet diameter ducts connecting the pressure vessel to four steam-raising units, two on each side of the reactor building. In these units the heat from the gas converts water into steam, which is then piped to the turbine hall, where it is used to drive two 85,000-kw turbo-generators.

Charging and discharging of fuel elements can be done while the reactor is on full load by means of a single machine operating above the reactor. The reactor is provided with the usual type of control system employing neutron-absorbing control rods, which can be raised and lowered in vertical channels interposed between the fuel channels through the core. An independent alternative shut-down device, which can be tripped manually and which operates automatically in severe earthquakes, has also been incorporated in the design. This device is effective even in the event of movement of the core relative to the pressure vessel. The operation of the complete power station is centrally controlled from a room in the reactor building.

Technical Improvements

In the design of this power station, full advantage has been taken of the valuable experience gained by G.E.C. and Simon-Carves in producing designs for installations in Britain and Europe and in building the station at Hunterston, near West Kilbride, Ayrshire, Scotland. After extensive research and development work, it has been possible to introduce many important technical improvements in order to increase the efficiency of the station. It has been necessary to adopt a modified approach to certain fundamentals in view of the potential earthquake hazard in Japan, and the resulting design is fully capable of meeting the stringent requirements

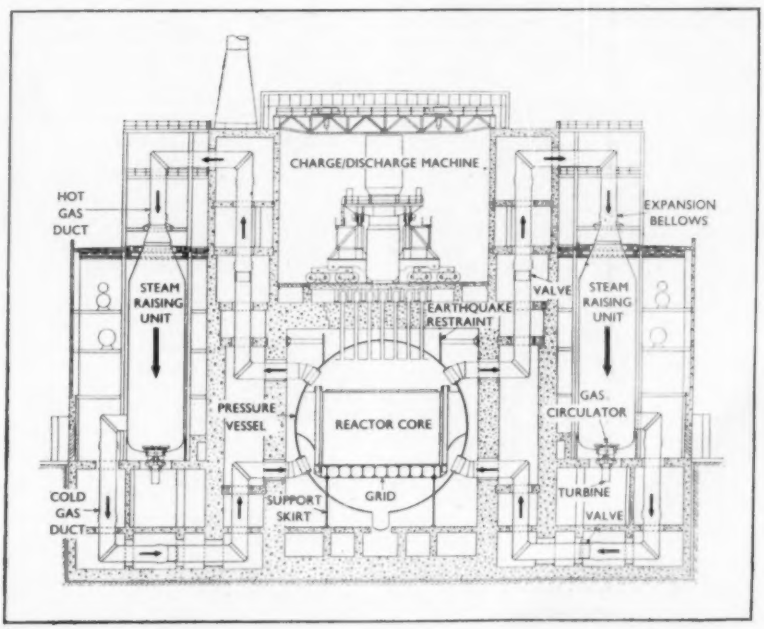
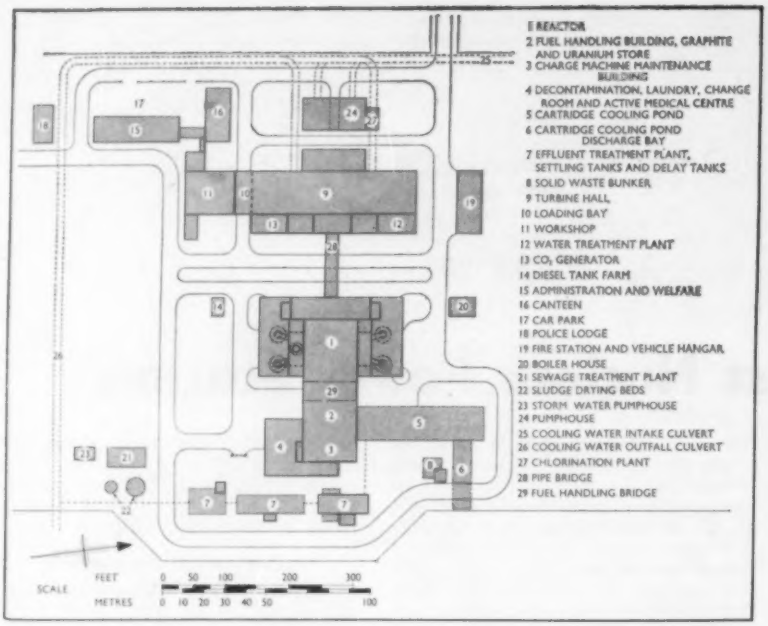


Fig. 1. A simplified sectional drawing of the General Electric Company's reactor for Japan's nuclear power station


1 REACTOR
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7 EFFLUENT TREATMENT PLANT, SETTLING TANKS AND DELAY TANKS
8 SOLID WASTE BUNKER
9 TURBINE HALL
10 LOADING BAY
11 WORKSHOP
12 WATER TREATMENT PLANT
13 CO_2 GENERATOR
14 DIESEL TANK FARM
15 ADMINISTRATION AND WELFARE
16 CANTEEN
17 CAR PARK
18 POLICE LODGE
19 FIRE STATION AND VEHICLE HANGAR
20 BOILER HOUSE
21 SEWAGE TREATMENT PLANT
22 SLUDGE DRYING BEDS
23 STORM WATER PUMPHOUSE
24 PUMPHOUSE
25 COOLING WATER INTAKE CULVERT
26 COOLING WATER OUTFALL CULVERT
27 CHLORINATION PLANT
28 PIPE BRIDGE
29 FUEL HANDLING BRIDGE
SCALE
FEET 0 50 100 200 300
METRES 0 10 20 30 40 50 100

Fig. 2. Proposed site layout for Japan's first nuclear power station, Tokai Mura

laid down by the purchaser to insure the safety of the installation under the most severe conditions.

One essential in the structural design was to ensure the integrity of the reactor building and its associated steam-raising plant as a complete unit so that no breach could occur in the gas circuits. The concrete substructures supporting the steam-raising units are, therefore, carried on the main reactor foundation raft to ensure uniformity of movement during earthquakes. The support system for the gas ducts connecting the reactor pressure vessel to the steam-raising units has been designed so that the stresses in the ducts and in their junctions with the pressure vessel are maintained at safe levels in all circumstances.

As a further measure to ensure the safety of the reactor, the reactor building itself houses all the plant necessary to guarantee the removal of all heat generated within the core, even if severe earthquake shocks should cause the fracture of all pipe connections between the reactor building and the turbine hall.

Reactor Core

The core of the reactor, including the graphite reflector which surrounds the core proper, is a 32-sided structure. It is supported inside the pressure vessel on a steel grid of "egg-box" construction, and the graphite blocks are held in place by a system of restraints in the form of a framework which encircles the whole core. This framework has been specially designed to hold the core accurately in position even during a severe earthquake.

The 62-ft diameter spherical pressure vessel which encloses the reactor core is fabricated from steel plates 3¼ in. thick. The steel used for this purpose has been specially selected to withstand the effects of prolonged irradiation.

The sphere is supported on a cylindrical steel skirt, and a further skirt is welded to the vessel near the top. This upper skirt is anchored to the biological shield as a precaution against disturbance during earthquakes.

Vertical standpipes, connected to the top of the sphere, pass upwards through the top shield, providing a means of access to the reactor core for control devices and charge–discharge equipment. Further standpipes house mechanisms capable of detecting any displacement of the core, pressure vessel, or support grid due to earthquakes, and of shutting down the reactor before the safety of the installation is jeopardized.

Fuel Elements

The fuel elements are fabricated from natural uranium metal, encased in specially finned cans of magnesium alloy. Each element is individually supported inside its own graphite sleeve, an arrangement which was originated by G.E.C. The weight of the stack of elements in a channel is thus transmitted through the sleeves so that stresses on the fuel rods themselves are kept to a minimum. By making the sleeves from a specially-treated graphite, which has a very low permeability to the coolant gas, it has proved possible to maintain the main moderator graphite at a temperature such that no significant storage of Wigner energy occurs during the life of the reactor.

Since the fuel in this reactor is charged and discharged from above, each element is provided with a grappling device which can be gripped by the charge machine grab. This device is made of a zirconium alloy, and is designed so that the cartridge itself cannot be damaged during refueling operations.

In this reactor, the charging and discharging of fuel elements are done from above the reactor. It will be recalled that G.E.C. were the first to develop bottom charge–discharge

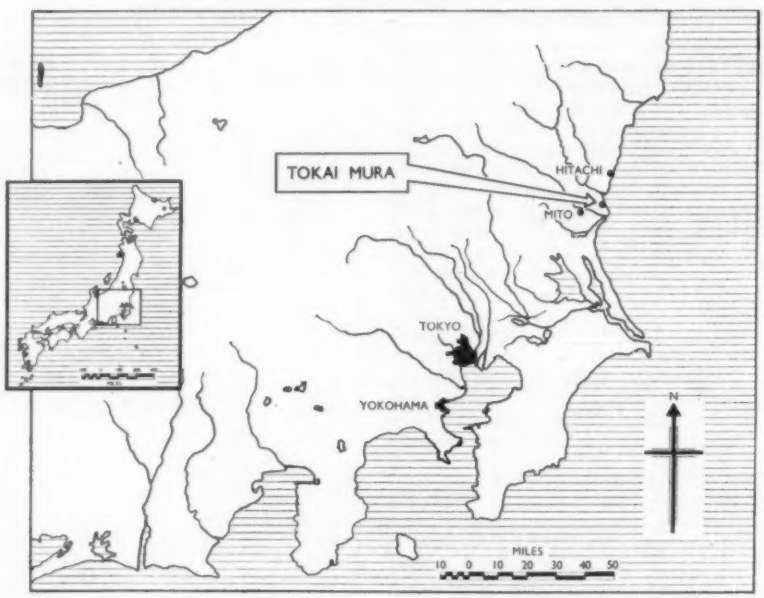

Fig. 3. Map showing the location of Tokai Mura in relation to Tokyo, the capital of Japan

equipment, which offers considerable practical advantages, but in this case they had to modify the design to meet the local circumstances. By the adoption of top charging arrangements, the center of gravity of the reactor building is lowered, thus improving its stability in an earthquake.

All normal refueling operations are conducted, while the reactor is on full load and under pressure, by a single machine traveling on a gantry above the top concrete shield. The same machine is also used for reactor servicing functions, including the planned maintenance of control mechanisms. A duplicate machine is installed to provide extra facilities during start-up and to permit the withdrawal of the first machine for maintenance.

Remote Control

Each charge machine is remotely controlled by a single operator from a desk housed in a control room at the edge of the pile cap. In order to ensure the correct performance of the machine's functions, highly developed sequence-control equipment is provided, the possibility of error being further reduced by the employment of a punched-card system for setting the requisite interlocks for any given operation. The operator can follow the working of the machine by means of mimic diagrams and closed-circuit TV equipment.

For all normal reactor-control functions, including emergency trips, the usual system of control rods is employed. Each rod is suspended from a stainless-steel wire rope, wound on an electrically-driven drum mounted in an extension to the associated top standpipe. The driving system provides accurate control of the rod's position in the core, and of its rate of movement at all times.

In addition to the normal control rods, an alternative device, completely independent of the control-rod system, is provided to shut down the reactor in the case of an emergency. This system will operate even in the remote possibility of the reactor core being greatly deranged by a violent earthquake.

Each of the four steam-raising units designed by Simon-Carves incorporates high and low pressure evaporators with economizer and superheater sections. The banks of specially-designed finned tubes, which make up these various sections, are mounted in a cylindrical pressure shell, 84 ft high and with an internal diameter of 21 ft 6 in. The tube supports and also the skirt on which the complete unit is carried are designed to withstand earthquake shocks.

Blowers Circulate Coolant

The carbon dioxide coolant is circulated through the reactor system by single-stage centrifugal blowers. One blower is mounted in the base of the pressure shell of each of the four steam-raising units, thus avoiding the need for large separate pressure casings. Each blower is driven by a steam turbine.

Housed in the turbine hall are two 85-mw turbo-generators, each comprising a dual-pressure steam turbine driving a hydrogen-cooled alternator incorporating a highly developed system of direct cooling for the rotor. Apart from the normal steam condensers, dump condensing plant is provided for duty during start-up and shut-down. Circulating water will be drawn from the Kuji River.

And Now—The Anti-Lambda

ONE of the most fascinating yet at the same time perhaps one of the most disconcerting aspects of nuclear physics research is the steady stream of new particles that emerge from the nucleus of the atom as the nuclei are subjected to higher and higher energy bombardment. It does not seem very long ago when the nucleus of the atoms was thought to consist only of neutrons and protons. Today, that concept has long been relegated to oblivion along with the Dodo and the dinosaurs. Today we have a veritable host of strange, fleeting particles coming from the nucleus, some of which would seem to belong more to the realm of science fiction than to the field of experimental physics.

Atomic nuclei are disturbed by means of probes, that is by beams of high energy particles. The probes range from protons, with energies of billions of electron-volts, to neutrons of less than 1 electron volt energy from nuclear reactors. The resulting events are studied by the use of a number of different techniques. The use of these probes usually results in the appearance of a variety of mesons and hyperons. These are strange names but they are typical of many others. All of them have an extremely transient existence and most of them turn into other types of particles. At Brookhaven, for example, in the first experimental confirmation of the existence of the neutral K-meson, having a mean existence much longer than 10^{-10} seconds, it was shown that this particle exhibited three modes of decay — into a pion, muon, and neutrino; into a pion, electron, and neutrino; and into three pions. This is just an example — we are not going to attempt to explain the nature of these particles; the only reason for mentioning them is to show what the experimental nuclear physicist has to cope with these days.

At present the list of experimentally discovered or inferred particles stands at 30, but there is no reason to suppose that there will not be more as research continues. None of the latecomers to the present list of particles has any part in the constitution of matter in the ordinary sense. All of them are unstable; most of them decay by *weak* interaction processes. It was, in fact, the recognition of the weak interactions as the hallmark of one distinct class of partical transformations that has given the first hint of some pattern and order in the multiplicity of particles.

The very latest of these new particles to make its appearance is a strange one called the anti-lambda. The lambda particle had already been discovered. The anti-lambda is the counterpart or mirror image of the lambda. Photographs exhibiting the presence of this particle of antimatter have been taken recently in the new six-foot bubble chamber at the University of California's Lawrence Radiation Laboratory.

One such photograph was shown at the International Conference on High Energy Physics meeting the week of July 24 in Kiev, Russia. The report on this work was made public simultaneously by the laboratory in Berkeley and the Atomic Energy Commission in Washington. The AEC supports the program of fundamental research in the Lawrence Radiation Laboratory.

The nuclear particles, generated in bombardments by the atom-smashing Bevatron at Berkeley, were photographed by a group headed by Dr. Luis W. Alvarez, professor of physics and associate director of the Lawrence Radiation Laboratory. The experiment was run by Dr. Lynn Stevenson, Assistant Professor of physics, and Dr. Philippe Eberhard, physicist on leave from the Centre National de la Recherche Scientifique de France. Both Alvarez and Stevenson were in Russia to attend the conference.

The photograph shown at Kiev is the second record of a nuclear event involving an anti-lambda. The first anti-lambda was observed on special type photographic plates exposed in the pi meson beam at the Berkeley Bevatron last year. The bubble chamber photograph, however, is the first record of the complete reaction containing the anti-lambda, including the particle which started the chain of events.

The anti-lambda belongs to a species of particles called hyperons. It has a mass of 2180 electron masses and has no electrical charge. There is only one other member of the lambda species, the ordinary lambda, which is also neutral in charge.

The Berkeley scientists hope to record more such reactions in experiments which are continuing. The bubble chamber pictures will permit precision studies of the anti-lambda and associated reactions.

Observation of the anti-lambda means that it is probable that other, previously unobserved particles of anti-matter, for example, the anti-sigma, will also be seen in the big bubble chamber. Previously, it had been thought that the anti-lambdas were produced in the Bevatron in such small numbers as to prevent their detailed study. It was widely believed that the systematic study of such particles would fall within the province of machines of higher energy, such as the Russian version of the Bevatron, which has the potential to produce them in greater quantity.

The work demonstrates the power of the new bubble chamber, which is the first of a number of big nuclear particle detectors now in the planning stages or on the drawing boards of high energy laboratories in this country, in Europe, and in Russia.

In the picture shown in Kiev the track of an anti-proton is seen to enter the chamber and disappear. From previous investigations the scientists know that at the end of the track, the anti-proton interacts with a proton in the chamber. After the gap, there are two brilliant v-shaped tracks, which are produced, one by the decay of the anti-lambda and the other by an ordinary lambda. The lambdas, both being electrically neutral and having no charge, make no tracks in the chamber. The lambda decays into a pi-negative meson and a proton. The anti-lambda decays into a pi-positive meson and an anti-proton. The anti-proton from the anti-lambda decay comes to rest in the hydrogen, annihilating with a proton and producing a four-prong star of pi mesons. Through analysis determining the particles and their energies in the v's, the scientists can demonstrate that the anti-lambda exists even though it makes no tracks.

This new subnuclear unit is the third particle of anti-matter to be created and discovered with the great Berkeley Bevatron. Earlier ones are the anti-proton, discovered in 1935, and the anti-neutron, discovered in 1956.

Anti-particles are *building blocks* in a bizarre state of matter constituting a kind of *mirror image* of the ordinary matter of which the earth and presumably our entire galaxy is made. The particles of such matter have properties such as electrical charge, spin, etc., that are opposite to those of conventional matter. "Anti" particles, being artificial creations of man, do not exist in the ordinary world on earth. In the ordinary world of matter, "anti" particles necessarily have only a brief life-time, for when they come together with ordinary particles, the result is mutual annihilation — new particles may be created but these quickly decay and disappear in the dissipation of the energy generated by the annihilation.

Much as these new particles tend to complicate the picture of matter, their production serves to balance the energy account. There is a tremendous difference in the time scale involved in the weak interactions in which these particles are produced as compared to the strong interactions. Even though the weak interactions take place within 10^{-7} to 10^{-10} seconds, such intervals are extremely long compared to the time of the strong interactions, which may be billions of times shorter.

From even this very brief account it will be obvious that there is still an immense amount of work to be done before we can expect to put together a really comprehensive picture of the ultimate nature of matter. It may take many years, but at the moment this field of research is perhaps the most fascinating in science's history.

New Nuclear Literature

Among all of the aspects of atomic power development, the one about which least reliable information has been available, is that concerning nuclear power costs. All sorts of estimates have been made by various individuals and organizations but few of these have been based on actual reliable data and as a consequence their value has been questionable. It is probably too early even now to attempt to estimate nuclear power costs with any degree of accuracy but those particularly concerned with costs will be interested in a new publication recently issued by the Office of Operations Analysis and Forecasting of the Atomic Energy Commission. This report, comprising some 30 pages, considers costs data of electricity from those plants that are presently in operation, being built, or planned for early construction. It does not deal with studies of subsequent plants or the role of nuclear power in meeting long-term energy demands. As indicated, the report is intended only for information and discussion and does not necessarily represent an official position of the AEC on any of the subjects covered. The material in this report is presented under the following headings: Capital Costs, Annual Fixed Charges, Fuel Cycle Costs, Inventory Charges, Cost of Operation and Maintenance, and Total Cost of Nuclear Power. It is pointed out that because of the many variables and uncertainties which affect nuclear power costs, no firm answers can be given at present for the total cost of nuclear power. Expected costs of electricity from those nuclear plants being built or planned for early construction, utilizing a pressurized-water or a boiling-water reactor, and having a net capacity of 150 electrical megawatts or more, are given as 11 to 18 mills per kilowatthour. Plant investment costs for plants of this type range from $300 to $400 per net electrical kilowatt. This report, TID-8506, is entitled *"Costs of Nuclear Power,"* dated, July 1959, is available from the Office of Technical Services, Department of Commerce, Washington 25, D. C., at a price of $0.50 per copy.

* * *

Another helpful book is the new *Directory of Nuclear Reactors, Volume I, Power Reactors*, recently published by the International Atomic Energy Commission in Vienna. On June 10 of this year this agency published this volume, containing a directory of power reactors now in operation or under construction in various parts of the world. This is the first major publication of the Agency but directories of other types of reactors are under preparation. The purpose of this directory, also, is to provide a source of easy reference for anyone interested in the development of the peaceful use of atomic energy, either at the technical or the management level. In selecting reactor projects for inclusion in this volume, the basic criterion was that they should be in regular operation and be producing useful electric power by the end of 1962. In all, 36 power reactor projects are included in the directory, 15 in the U. S. A., 8 in the United Kingdom, 4 each in France and the USSR, and one each in Belgium, Canada, Czechoslovakia, Germany (Federal Republic) and Sweden. In some cases the projects comprise more than one reactor. The reactors are grouped in six categories according to the coolant used, e.g., gas-cooled, liquid-cooled, metal-cooled, etc. The information is presented in a uniform manner, enabling the reader to make a quick reference to the principal features of the various reactors and compare them rapidly. All data contained in the directory have been either provided or reviewed by the authorities of the countries concerned, and can, therefore, be considered as the best available at the present time. Because of the close cooperation of IAEA's Member States, it was possible to include a number of projects about which no information had hitherto been generally available. *Directory of Nuclear Reactors: Volume I Power Reactors* is available from the International Atomic Energy Agency, Karntner Ring, Vienna 1, Austria. Price, U. S., $3.50.

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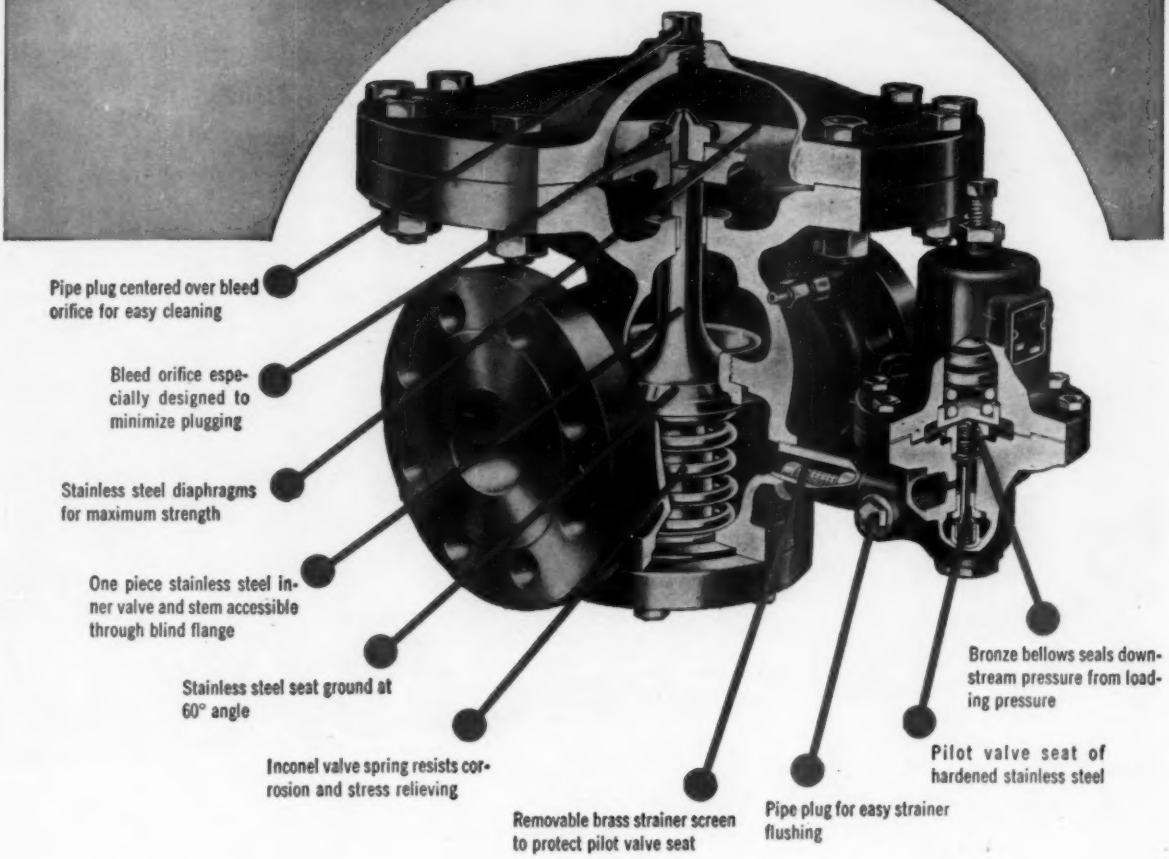
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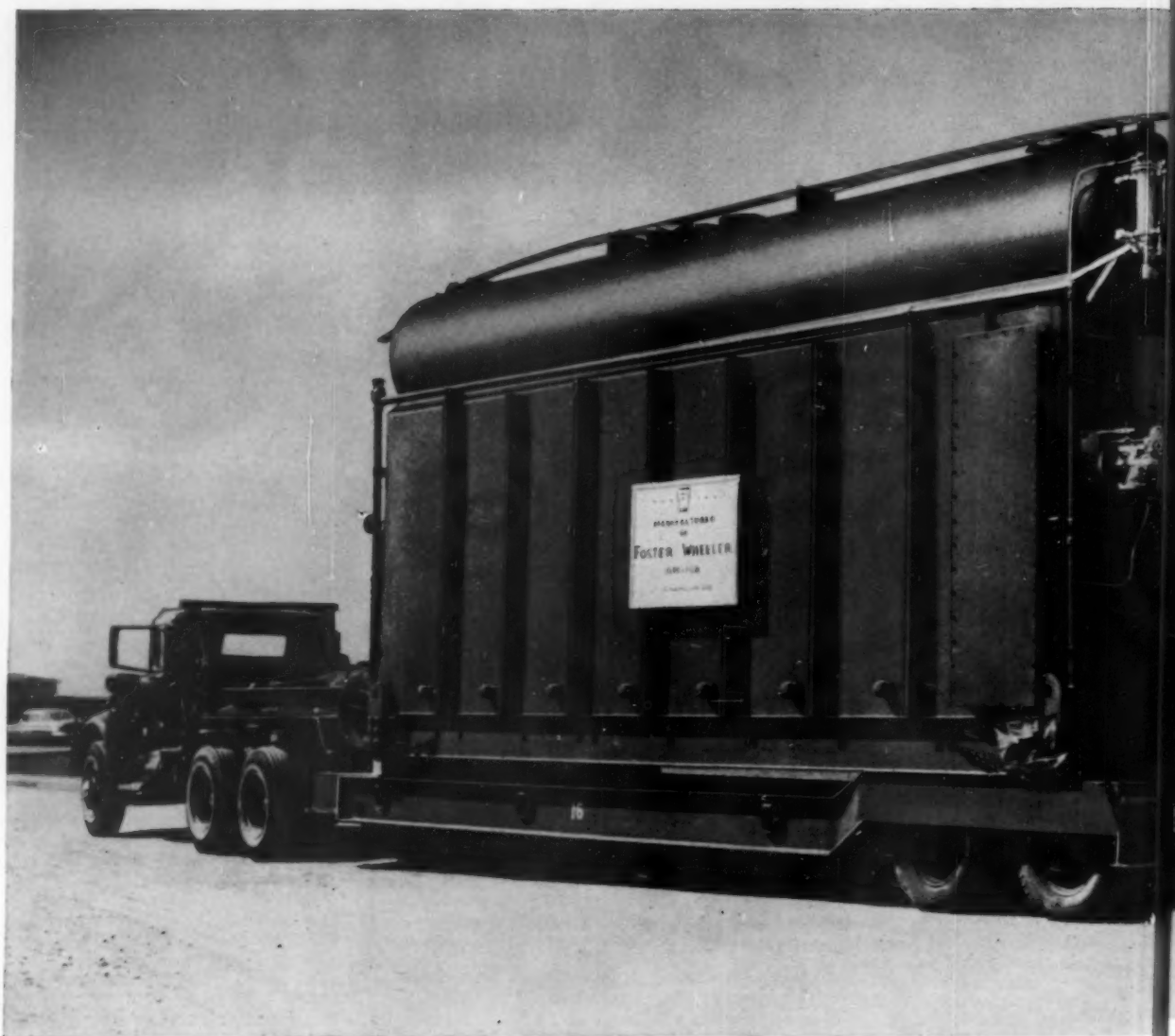

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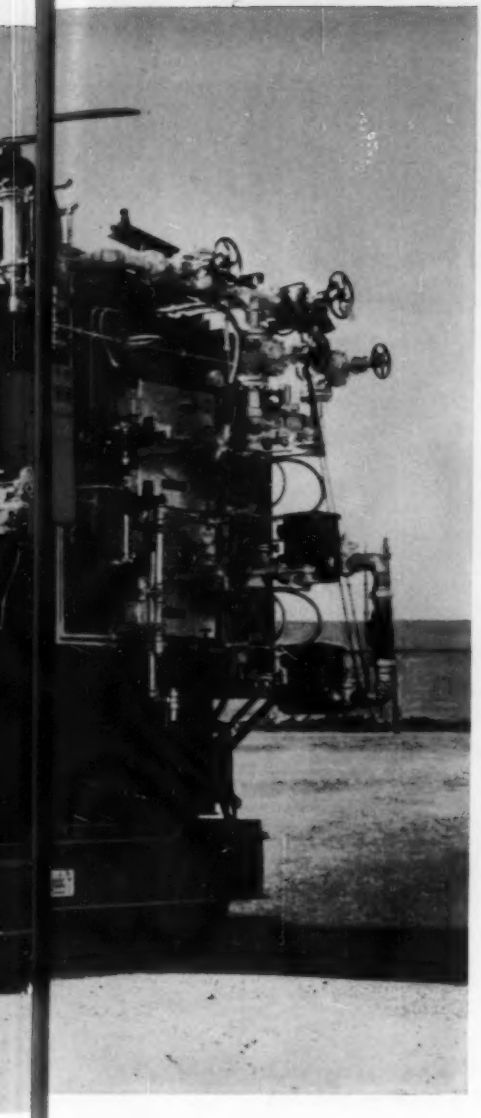

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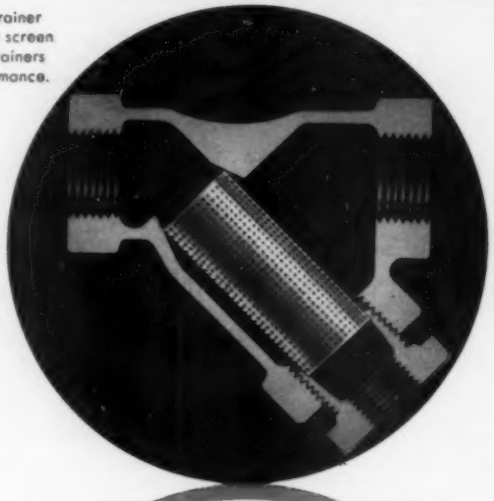

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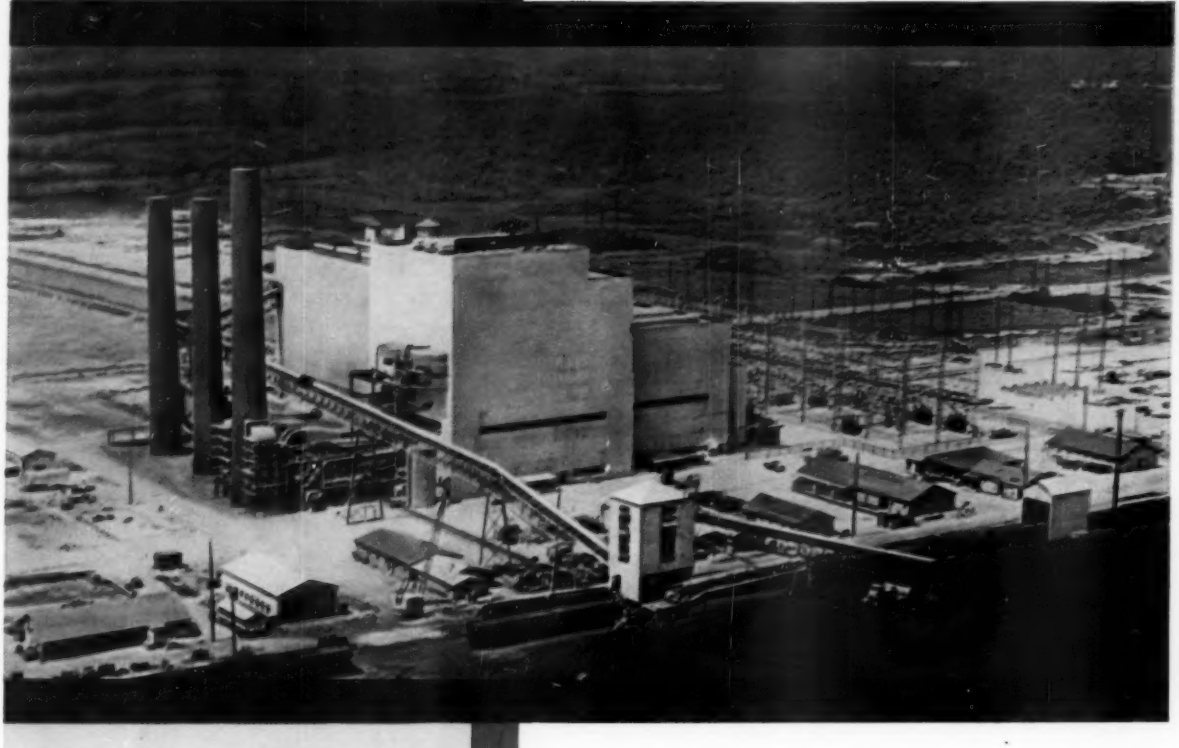

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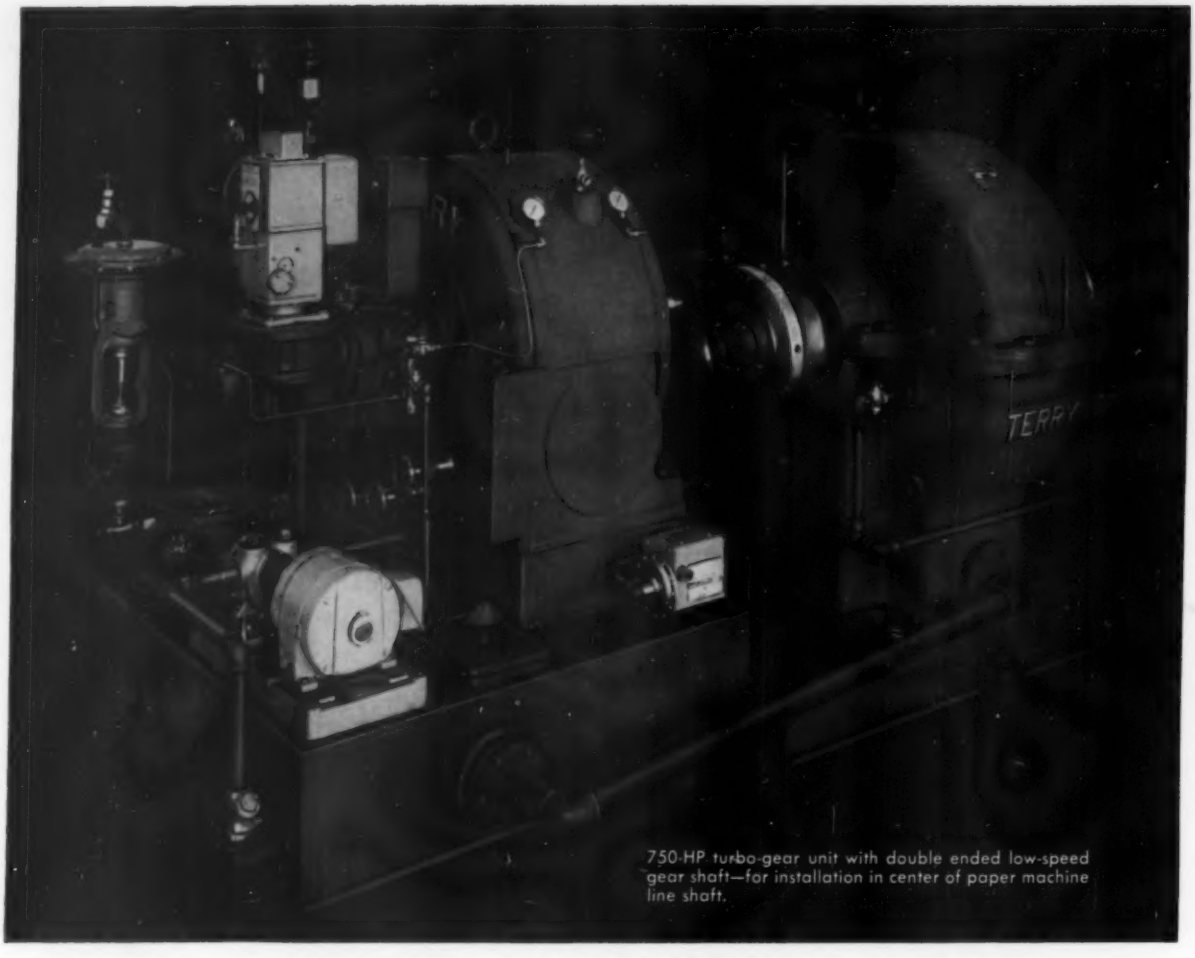

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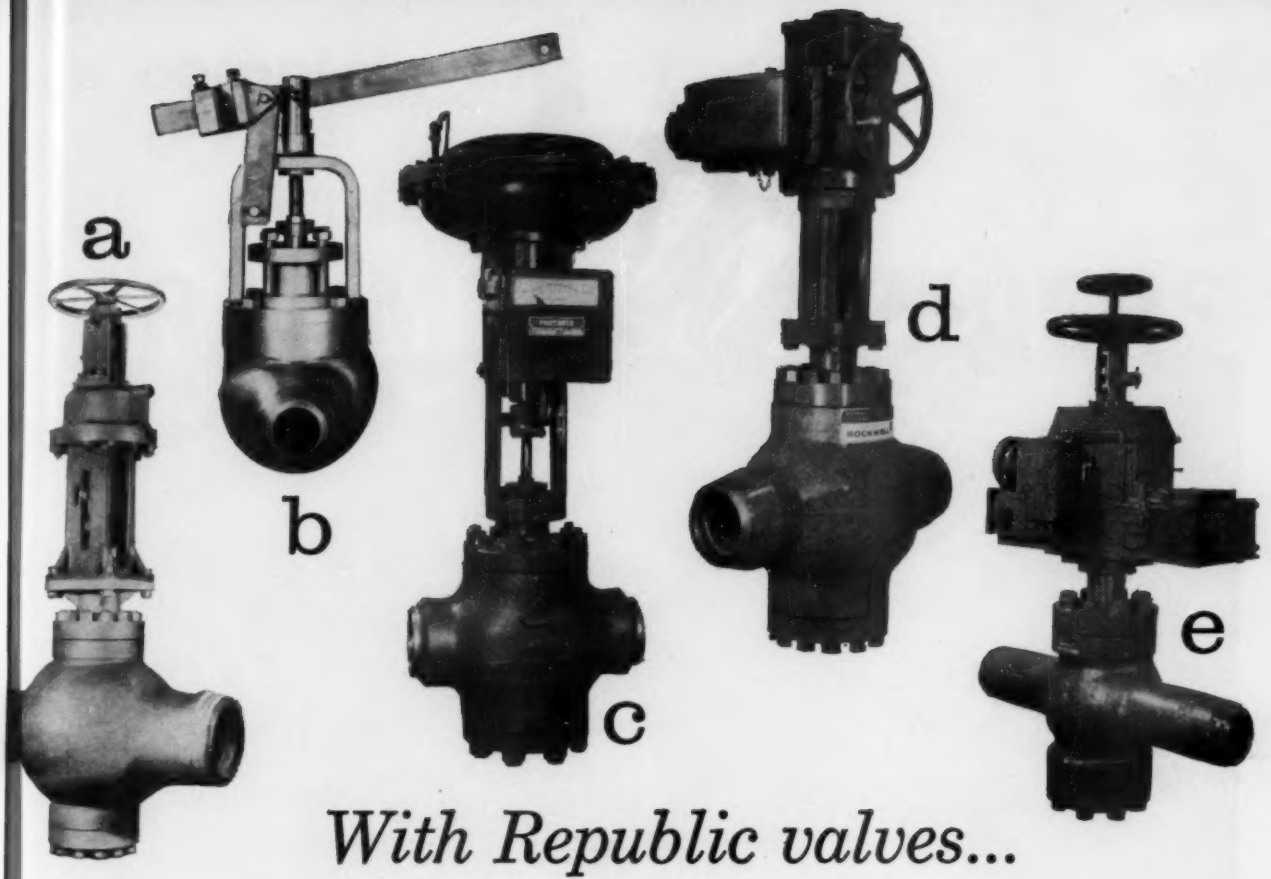

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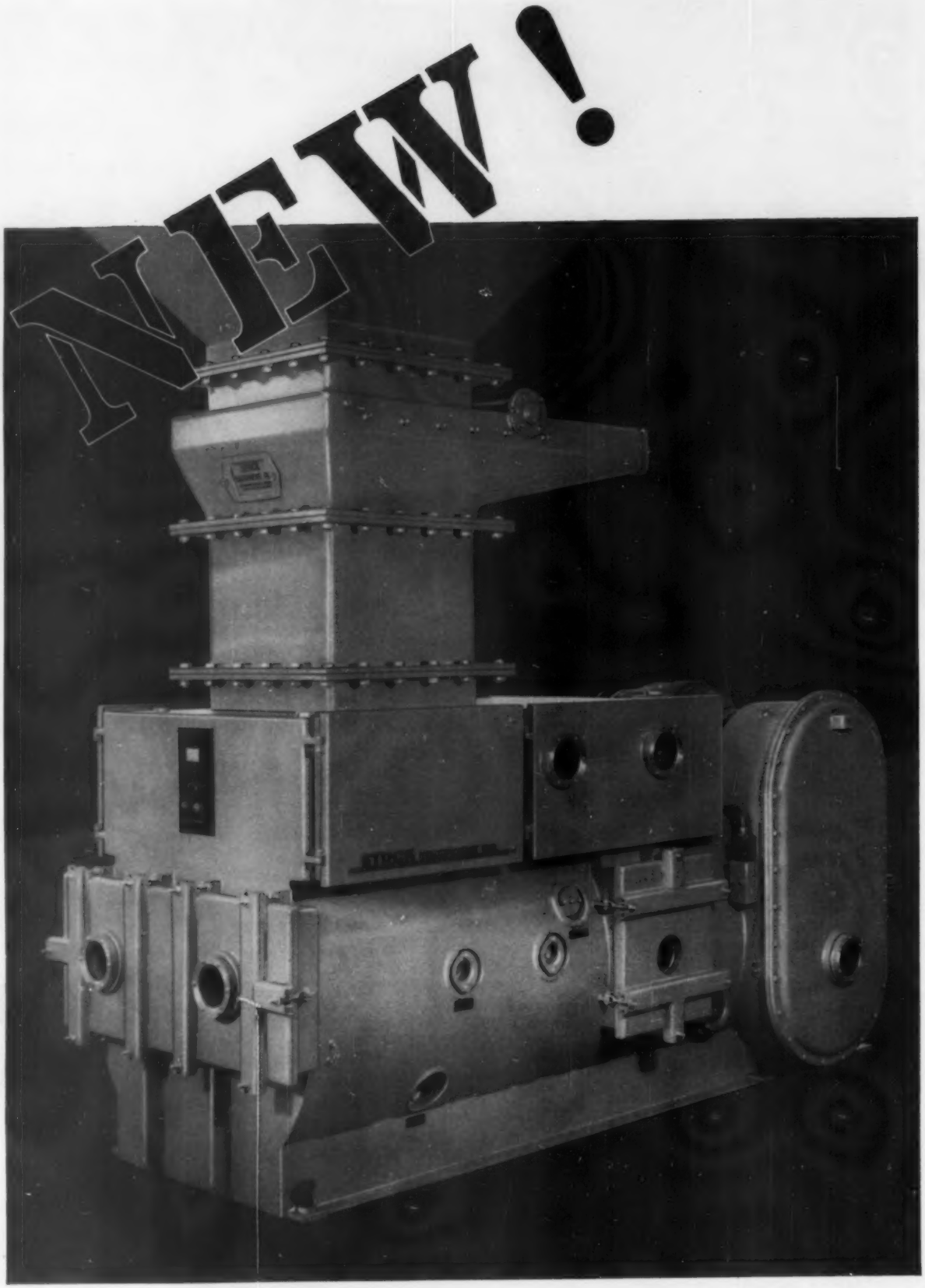
e. **Toggle head operated valve**
f. **Diaphragm operated angle valve**

And, for many special applications, such Republic accessories as pneumatic and electric valve positioners for hysteresis-free control, and a complete line of controllers are available.

Whatever your regulating valve problem, let Republic engineers put their years of application experience to work for you. For additional information, see your Republic representative, or write to Republic Flow Meters Company, 2240 Diversey Parkway, Chicago 47, Illinois.

REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL

For more data circle 522 on Post Card


NEW!

a complete line of

GRAVIMETRIC FEEDERS

S-E-Co. Gravimetric Feeders assure you of reliable coal feeding to your pulverizers or cyclone burners. The width of coal stream from inlet to outlet is a full, uninterrupted 24". Wet, sticky coal is handled readily with no trouble. In addition to reliability, S-E-Co. Gravimetric Feeders offer you gravimetric control of energy input. Coal feed rate to each pulverizer or cyclone is controlled by weight, permitting close regulation of fuel-air ratio and accurate distribution among burners. The rate of coal feed in pounds per hour is indicated on your boiler panel. A complete line of S-E-Co. Gravimetric Feeders is available to meet your type and capacity requirements.

Include S-E-Co. Gravimetric Feeders in your next boiler specification.

Write for bulletin.

by STOCK Equipment Company
723 HANNA BUILDING • CLEVELAND 15, OHIO

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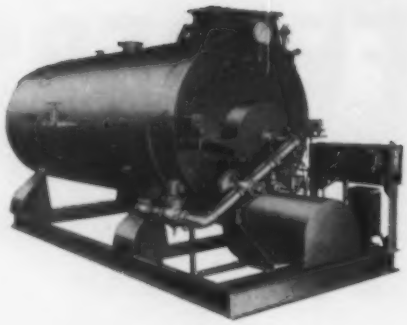
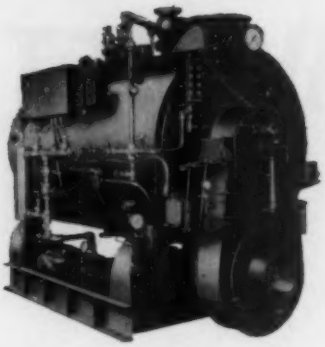
Only CYCLOTHERM



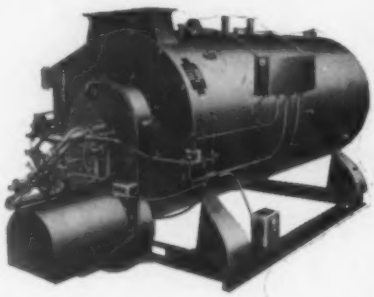
CYCLOTHERM INDUSTRIAL LINE

One Cyclotherm sells another! Repeat orders from satisfied users have put batteries of Cyclotherms in many of America's outstanding plants. We'd be happy to send you actual case histories. 18 models. 15 to 750 HP.



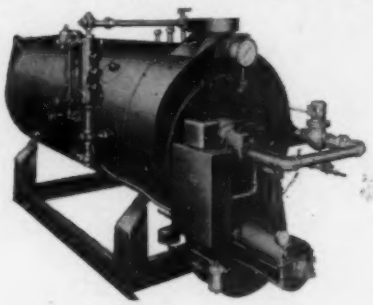
CYCLOTHERM MC (MARINE) LINE

A Cyclotherm Marine Boiler is installed on the nuclear ship Savannah. During and since World War II Cyclotherm Marine Boilers have been widely used by the U.S. Navy. Built to meet limitations of shipboard space. 6 models. 800 to 7,500 lbs. of steam per hr. All models burn Diesel oil.



CYCLOTHERM (CW) HOT WATER LINE

Cyclotherm pioneered the construction of Packaged Hot Water Generators, specifically designed for forced circulation systems. The Cyclotherm Hot Water Generator has broken away from principles of steam design and is a true hot water boiler. Available in 10 models; 670,000 to 6,700,000 BTU per hr.

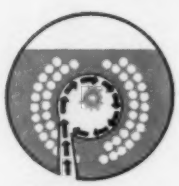


CYCLOTHERM (CE) LINE

Newest Cyclotherm line . . . 15 to 60 HP . . . built for requirements of Wholesaler, Contractor and Original Equipment Manufacturer. For the first time, a low-priced quality boiler in the small packaged-boiler field.

Here's how Cyclonic Combustion Operates-

1. At a tangent, air is injected into the cylindrical combustion chamber at a velocity of up to 200 miles per hr. The air mass assumes a cyclonic shape and motion in the firetube.



2. Seconds later, the fuel . . . oil or gas . . . is injected into the hollow center of the air mass. Co-ordinated ignition provides immediate combustion with maximum safety.

3. After ignition the atomized fuel vaporizes, forming a swirling vortex of flame that spirals the entire length of the furnace. A thin layer of air separates flame from furnace.

Packaged Boilers

with exclusive *Cyclonic Combustion*

Give You More Power, Performance and Production From Less Investment, Space and Fuel!

Whether in industrial boilers . . . marine boilers . . . hot water boilers or in the new CE boilers just off the production line . . . every Cyclotherm incorporates the exclusive, patented principle of Cyclonic Combustion. And only a Cyclotherm can give you the advantages that Cyclonic Combustion offers.

Cyclonic Combustion results in complete and perfect diffusion combustion of gas and liquid fuels. The cyclonic action of the flame accounts for 65% to 70% heat transfer in the firetube with 15% to 20% additional transfer in the return tubes. No other combustion method can equal the heat transfer obtained with Cyclonic Combustion – and heat transfer is the ultimate measure of boiler efficiency.

Up to ⅓ Smaller

Cyclonic Combustion makes possible the simplified design of Cyclotherm Packaged Boilers, giving you maximum capacity from minimum space. By adding Cyclotherms as you need them, you can easily keep pace with plant expansion and increased steam requirements.

Dual Fuel Systems

Cyclotherms are designed to operate efficiently on either oil or gas. A combination fuel system can be furnished to allow you to take advantage of fluctuations in fuel supply or price. Cyclotherm's design squeezes all the latent energy from every molecule of fuel burned.

Easy, Low Cost Installations

With five simple connections—steam, electricity, water, fuel and stack—Cyclotherms reach your plant ready to operate. You don't need special foundations or expensive stacks. Your regular maintenance personnel can operate any Cyclotherm.

Assured Safety

Cyclotherms are built under highest quality control standards, meet ASME and National Board of Boiler and Pressure Vessel Inspectors requirements, carry Underwriters' Laboratories label. In case of an interruption in fuel supply or breakdown in the electrical control circuits, Cyclotherms "fail safe."

New...Just Completed... For Engineers Only!

A sound-film, in full color, CYCLONIC COMBUSTION AND HEAT TRANSFER, which explains every detail of Cyclonic Combustion. This is not a promotion piece; it is a serious study of combustion principles, written by engineers and intended for engineers only. Write for full information on how your engineering staff or society can see this mathematical demonstration of what Cyclonic Combustion does. Just tear off the corner of this ad and clip to your letterhead—we'll do the rest.

4. With a 65-70% heat transfer in the firetube and 15-20% heat transfer in the return tubes, a minimum of 80% efficiency is the result.

YEARS AHEAD IN STEAM & HOT WATER GENERATION

CYCLOTHERM®

STEAM AND HOT WATER GENERATORS

A Division of National-U.S. Radiator Corp.
50 E. First St. Oswego, N. Y.

For more data circle 542 on Post Card

Steel stack is protected from corrosion by concrete lining made with **Atlas Lumnite Cement**

At Pennsylvania Power Company (New Castle, Pa.) this stack interior was recently gunited with a mixture of Lumnite calcium-aluminate cement and sand aggregate.

This monolithic concrete lining will protect the stack from corrosion, abrasion and high temperatures.

Concrete made with Lumnite cement can be cast in place, plastered against the shell or gunited. It reaches high strength in 24 hours.

For convenience, manufacturers of refractories offer castables bonded with Lumnite cement – packaged mixtures ready for use with just the addition of water. For more information, write Universal Atlas, 100 Park Avenue, New York 17, N. Y.

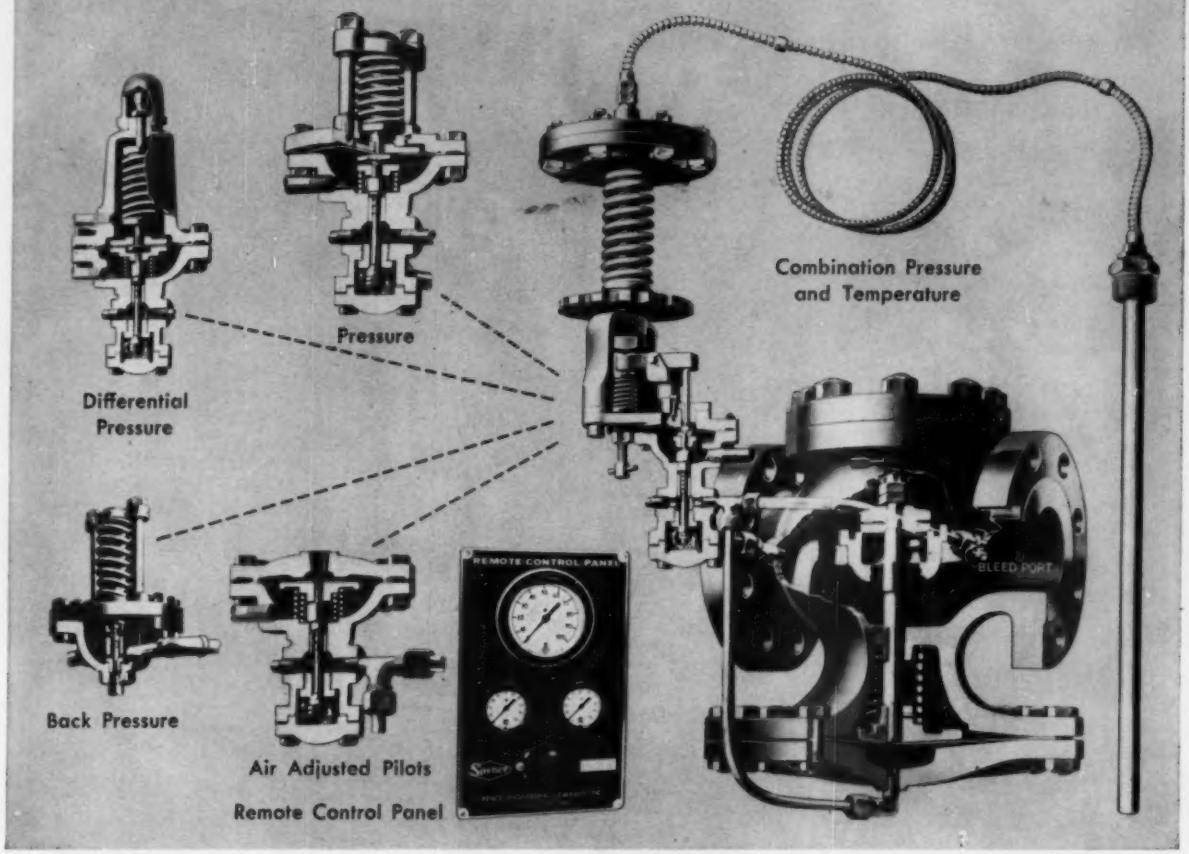
"USS," "Atlas," and "Lumnite" are registered trademarks L-183

Universal Atlas Cement
Division of
United States Steel

OFFICES: Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco

For more data circle 533 on Post Card

All Pilots Fit All Main Valve Sizes Downtime, Maintenance, Inventory Reduced



Let's start off by admitting there's no such thing as a "maintenance-free" regulating valve. Any valve that automatically controls temperatures or pressures within close limits can be affected by dirt in steam lines.

If trouble does develop, engineers want a regulator they can get back on the line — fast. That's one reason why more engineers are standardizing on Spence Regulating Valves with externally mounted pilots. The simple test of disconnecting the external bends establishes whether the trouble is in the main valve or the pilot.

If the main valve is the trouble spot, it can be maintained without removing the valve body from the line. If the pilot is the trouble spot, it is easily removed for cleaning. However, if production downtime is a strong factor, the fastest method is to install a spare pilot and it is inexpensive.

All Spence pilots fit all sizes of Spence main valves. If you have twenty pressure regulators, for instance, all you need is *one spare pilot*. It will fit all main valve sizes from ¼" to 12".

Another advantage of the Spence design is the external pilot is interchangeable. You can change the function of a regulator by merely changing the pilot. In many plants this can represent an important factor in reduced inventory costs because you only carry a few inexpensive extra pilots instead of complete regulators. Obviously, there is also a considerable savings in labor costs when a valve can be converted, in the line, from a temperature regulator to any one of various pressure regulators.

The pictures above show a few of Spence's wide line of automatic regulators. For more information write for Bulletin TE.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York SE-145

For more data circle 534 on Post Card

New
CYCLO-TRELL
MECHANICAL
DUST COLLECTORS

These new Cyclo-trells can be built to fit any specific job. Available in Types C-10 (10″ diameter), C-24 (24″ diameter), IC (involute Cyclo-trell), ICL (involute Cyclo-trell, lined) and C-24-L (24″ lined). Also available: a new hopper discharge valve.

Write now for your copy of new Bulletin 300 which gives details and illustrations of the new Cyclo-trells and hopper discharge valve.

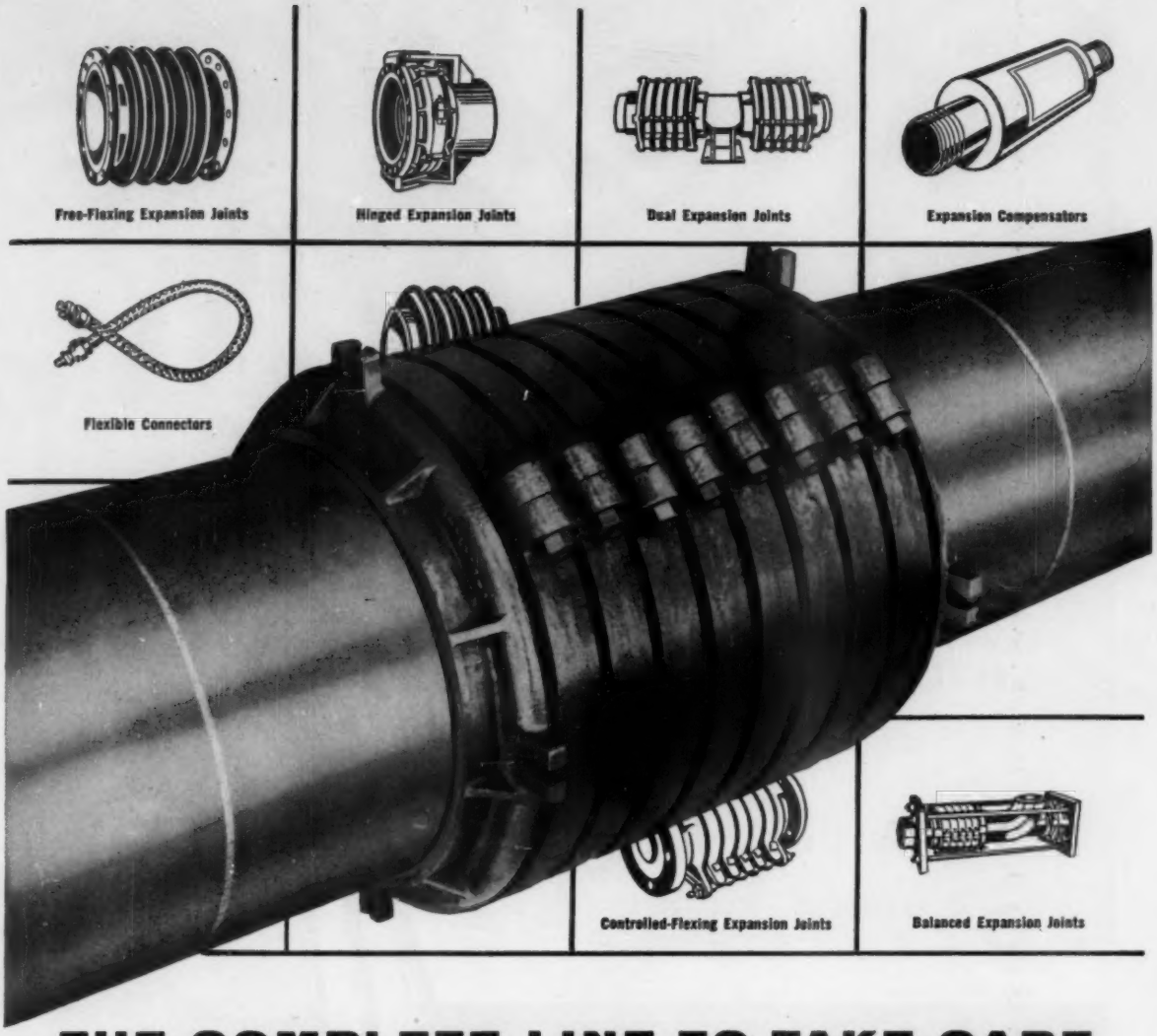
Research-Cottrell, Inc.

RESEARCH COTTRELL INC
TRADEMARK RC 203

Main Office and Plant: Bound Brook, New Jersey

REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA

For more data circle 535 on Post Card



THE COMPLETE LINE TO TAKE CARE OF ANY KIND OF PIPE MOTION

Flexonics has the equipment – as well as the experience and the skill – to take care of any kind of pipe motion problem. Here's where you benefit from more research . . . more metallurgical care . . . more service . . . and now standard stock sizes for quick delivery from Flexonics warehouses. They all add up to expansion joints that you can *install and forget* – plus expansion compensators, flexible connectors, and the all-new Flexonics pipe alignment guides–to take care of any kind of pipe motion!

Today—write for your copy of the Flexonics Expansion Joint Design Guide . . . 28 pages of valuable information.

Member Expansion Joint Manufacturers Association

EJ-535

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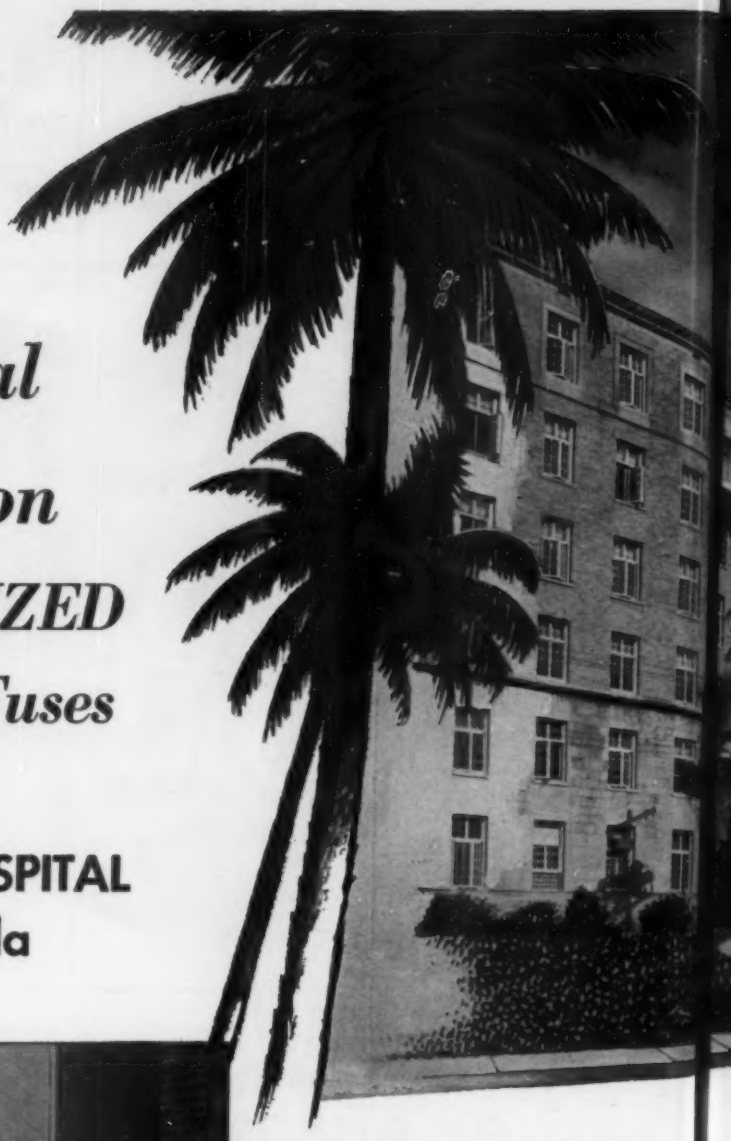
In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario

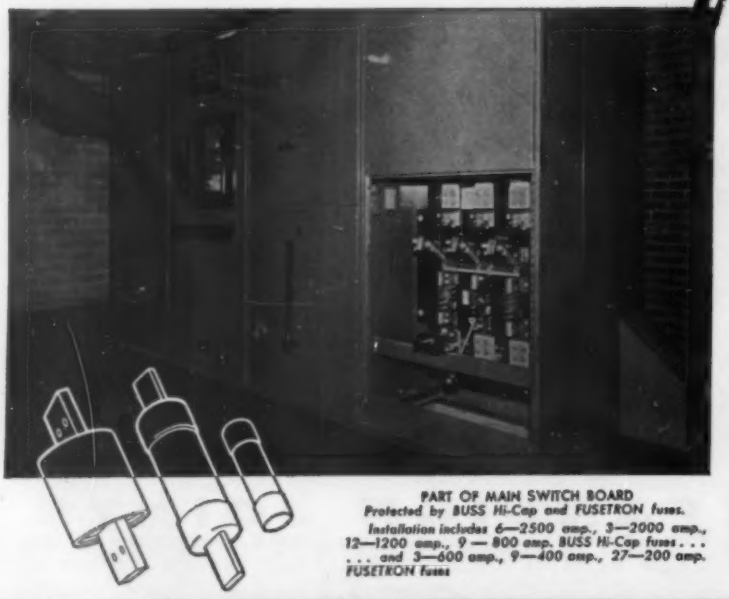
For more data circle 536 on Post Card

Electrical Protection is MODERNIZED with BUSS Fuses

in the

TAMPA CITY HOSPITAL
Tampa, Florida





PART OF MAIN SWITCH BOARD
Protected by BUSS Hi-Cap and FUSETRON fuses.
Installation includes 6—2500 amp., 3—2000 amp., 12—1200 amp., 9 — 800 amp. BUSS Hi-Cap fuses . . . . . and 3—600 amp., 9—400 amp., 27—200 amp. FUSETRON fuses

In this beautiful hospital, tremendous in size, it was found necessary to increase the capacity of the electrical system to meet today's requirements. Modernization of the electrical system resulted in estimated available fault currents of 150,000 amperes.

With faults of this magnitude possible, it became essential that a superior type of protective device be used.

So in the main switch board are BUSS Hi-Cap fuses and FUSETRON dual-element fuses, both applied to give the interrupting capacity and dependability needed on the circuits they protect.

ANOTHER BUSS HI-CAP AND FUSETRON FUSE INSTALLATION

ARCHITECTS AND ENGINEERS: *Norman F. Six and Elliot C. Fletcher, Tampa and Schmidt, Garden and Erikson, Chicago*

CONTRACTOR: *Miller Electric Co., Jacksonville, Fla.*

WHY HIGH INTERRUPTING CAPACITY IS NEEDED

Fault currents of 75,000 or 150,000 amperes were unheard of a few years ago, — but today they are quite possible. With the generating capacity of utilities increasing yearly, most likely the magnitude of fault currents will be higher in future years.

BUSS Hi-Cap and FUSETRON dual-element fuses have an interrupting capacity designed for today's conditions and to anticipate system growth.

The interrupting rating of BUSS Hi-Cap fuses is 200,000 amperes rms symmetrical — and for FUSETRON fuses it is 100,000 rms symmetrical.

WHY DEPENDABILITY IS NEEDED

With higher fault currents available, the dependability of the protective device becomes of increasing importance.

The protective device should be just as accurate in 10, 15, or 20 years, as it is on the day installed.

A fuse is the only type of protective device to offer this advantage. A fuse must remain safe and accurate, as its operation depends on a simple thermal law. A fuse has no triggers, latches, pivots or contacts to stick or get out of order. Dust, fumes, corrosion or age cannot increase a fuse's capacity or lengthen its blowing time.

for more information

On FUSETRON dual-element fuses - (loads of 0 to 600 amps.) - *write for bulletin FIS*

On BUSS Hi-Cap fuses - (loads above 600 amps.) - *write for Bulletin HCS*

BUSSMANN MFG. DIVISION, *McGraw-Edison Co.* **ST. LOUIS 7, MO.**

For more data circle 537 on Post Card

Be sure you are near the world's largest Coal Reserves for a low-cost, unlimited fuel supply

Since your fuel costs are governed to a large extent by transportation charges, it is *good business* to locate your new plant near a large, dependable reservoir of coal. PEABODY, with two billion tons of proven reserves, can help you select that site . . . where your burning equipment can be fed from one of PEABODY'S ultramodern mines and coal processing plants. Result: your assurance of an economical coal supply far into the future. Long-range planning is an important part of our business. May we be of service to YOU? *Get your free booklet, "This Is Peabody Coal Company", and learn more facts about PEABODY and its complete coal service. Write Department PE.*

power for progress

PEABODY COAL COMPANY

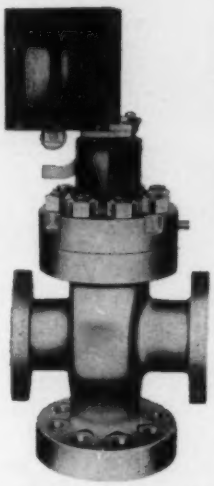
Peabody Plaza, 301 Olive Street, St. Louis 2, Missouri

GENERAL OFFICES: PEABODY PLAZA, ST. LOUIS. OFFICES IN: CHICAGO, DES MOINES, KANSAS CITY, LOUISVILLE, MADISON, WIS., MEMPHIS, MINNEAPOLIS

For more data circle 538 on Post Card

PRESSURE LOADED SEATING

minimizes leakage and maintenance



Consolidated Electromatic Relief Valve. Sizes: 2½" to 14". Pressures to 3000 psi. Temperatures to 1120°F. Double Outlet.

Consolidated Electromatic® Relief Valves save steam, pure water, fuel, and "wear and tear" on your spring-loaded valves. Pressure loaded seating permits closer adjustment between operating pressure and set point than in spring-loaded valves. Many Electromatics are used to purge superheaters for faster startups and as superheater vent valves. They greatly reduce chances of superheater damage when firing up a cold steam generator or banked boiler.

Pressure loaded seating is created by channeling steam from the pressure vessel around the Electromatic's exhaust and into its main and pilot valve chambers. Steam pressure in both chambers always matches that in the vessel when the Electromatic is closed.

When pressure exceeds the Electromatic's set point, a signal from controller to panelboard control station results in solenoid thrust that opens the pilot valve, venting the steam faster than it can enter the pilot valve chamber through the clearance between the main valve disc and guide. With pressure in the chambers unbalanced, the main valve opens; steam exhausts until boiler pressure is reduced to the pre-determined setting of the controller. The pilot valve and the main valve close instantly at this point. Action is so fast, the closely adjusted Consolidated Electromatic normally relieves overpressure before the spring-loaded valve's set point is reached. For automatic or manual operation or to cut the valve out of service, a switch is provided on the control station. Send for Bulletin 720.

CONSOLIDATED SAFETY VALVES

A product of

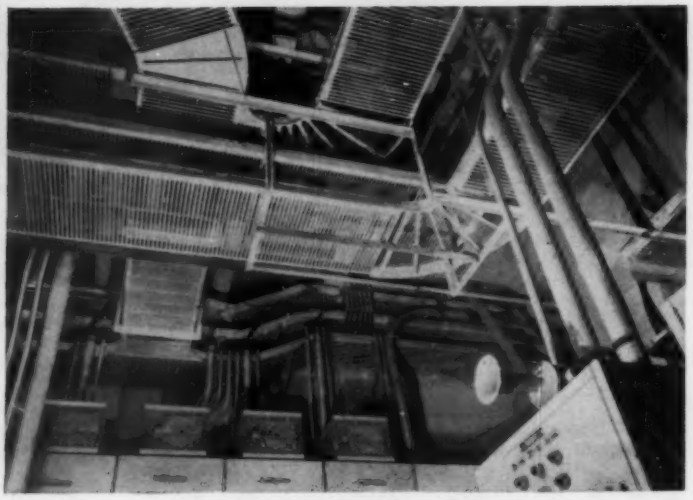
MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

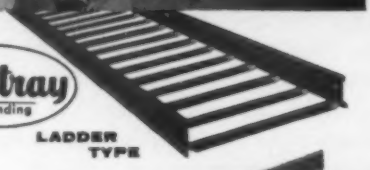
For more data circle 539 on Post Card

how INLAND STEEL uses GLOBE INTERCHANGEABLE TRAYS to support cables in their Indiana Harbor Plant

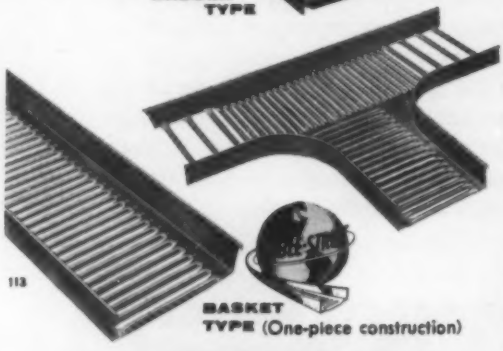
★ Engineered for Uniform Design and Easy Installation
★ Steel or Aluminum Construction
★ Complete Accessories for SPEEDIER Installation
★ Complete Interchangeability
★ No Sharp Edges to Damage Cables



Globetray
Pat. Pending



LADDER TYPE



BASKET TYPE (One-piece construction)

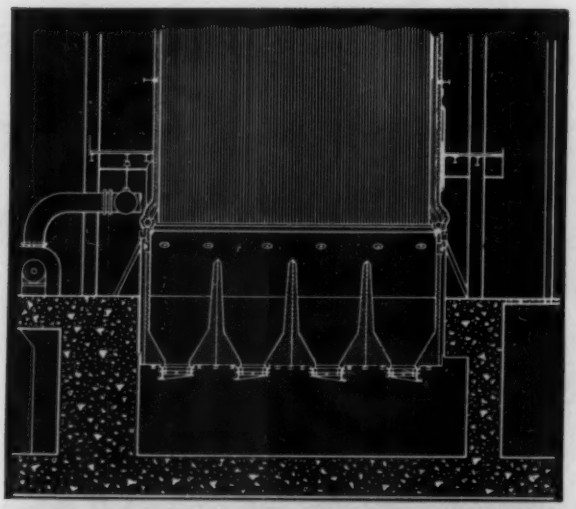
Globe's two types of cable trays, one a ladder type and the other a basket type, to support cables, wiring and tubing have become increasingly popular because they can be used INTERCHANGEABLY at any given location depending on the type and weight of the cables to be suspended. The advantages of each type tray can be used to the fullest. Globetray, the ladder type, is intended for use where festooning is not a problem, while Cable-Strut, the basket type, is used for the support of communication wire, instrument tubing and control cables in automation applications.

These two cable trays have been thoroughly field tested in hundreds of large industrial installations, in new plant construction, in power plants and for power distribution in all types of manufacturing processes. Send for FREE catalog giving full information and installation techniques.

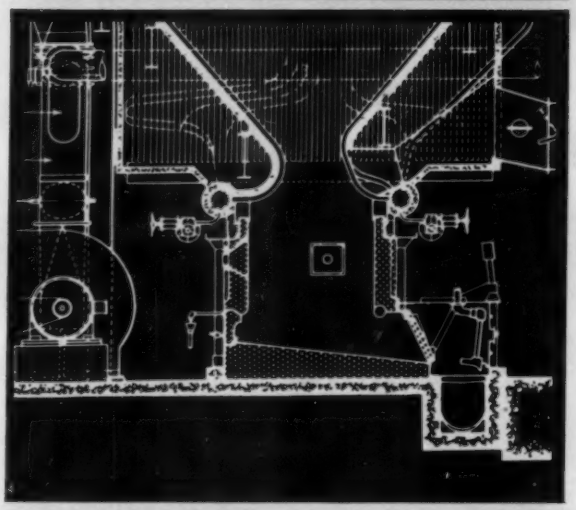
PRODUCTS DIVISION
THE GLOBE COMPANY Manufacturers since 1914
4022 S. Princeton Ave., Chicago 9, Ill.

Representatives in all principal cities . . . consult the yellow pages in your phone book under "Conduits" for the one nearest you.

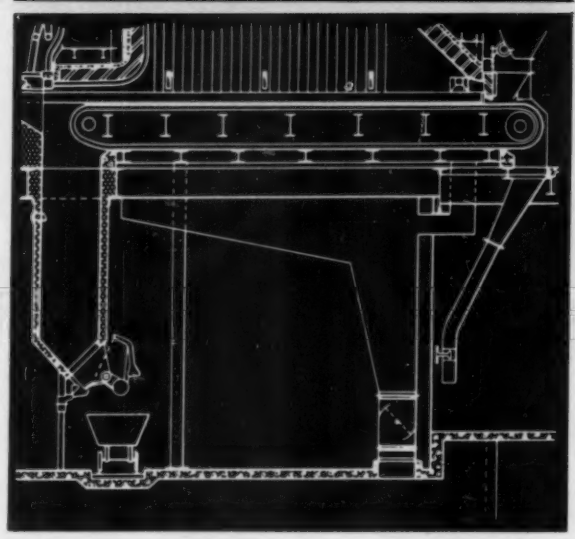
For more data circle 540 on Post Card



Erosion, due to dry ash sliding down the hopper, is the big problem in this ashpit.



Water jets can cause abrasion of ashpit floor refractories, and water splattered on the walls may cause spalling.



Continuous deposits of ash from a stoker-fired boiler have an abrasive effect on this ashpit lining.

Reduce refractory wear in ashpits with B&W Kaocrete

Relining ashpits is expensive. That's why power engineers specify heavy-duty B&W Kaocrete-D. On job after job, in all types of ashpits, this refractory castable has withstood the heavy abrasive and erosive attacks of sprays, jets, rakes and shovels.

The reason? Specially designed B&W Kaocrete-D has the strength and hardness needed for tough ashpit service. It has unusually high resistance to abrasion, erosion and spalling. It also saves time because it can be cast or gunned in place.

For the facts and figures on Kaocrete-D, as well as Kaocrete-A which is recommended for less severe applications, consult your local B&W Refractories Engineer.

Send for Bulletin R-40 which gives data on B&W Kaocrete Refractory Castables for lining ashpits.

R-609

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS: B&W Alumul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide B&W Ramming Mixes • B&W Kaowool

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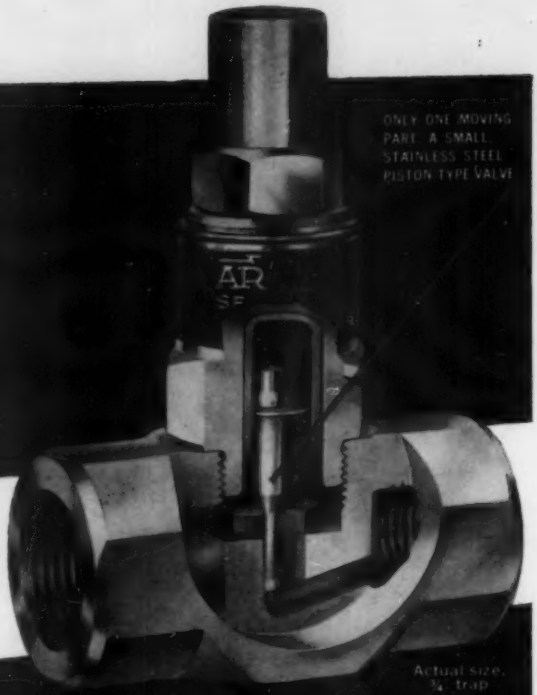

YARWAY impulse®

Yarway Impulse* Traps are the only steam traps that continually test for condensate in the line ahead of the trap and operate to discharge it as soon as it forms.

You gain by higher temperatures, steadier temperatures, peak operation of steam heated equipment at all times.

* A COMPLETE LINE OF STEAM TRAPS, ALL OPERATING ON A PROVEN THERMODYNAMIC PRINCIPLE.

Manufactured by YARNALL-WARING CO., 100 Mermaid Avenue, Philadelphia 18, Pa.
Stocked and sold by 270 Industrial Distributors.
Write for free bulletin "The Why and How of Steam Trapping."

For more data circle 542 on Post Card

TRACERS

Power Engineering's Monthly Probe of Power Facts

Electric power generated by industrial plants is on the upward swing, although total power use by industry is increasing even more rapidly. What does this trend mean in terms of equipment design and operation? J. E. McConnell gives a thorough analysis of the future of industrial power generation, page 72.

A leading member of the Association for Applied Solar Energy has invented a portable solar barbecue grill which doesn't need any fuel — only sunshine — and which folds up like an umbrella. A 4-ft aluminum reflector focuses the sun's rays on a 10-in. grill. Called an "umboiler," it's available commercially.

One of the most important engineering problems in the design of nuclear power reactors is that of heat removal. Unlike an ordinary boiler, a reactor can produce any desirable amount of power in any increment of time. This being so, where should we stop? Because of the absolute safety required, heat transfer engineers have developed what is known as the hot channel concept. In plain words this is the region in the reactor core where things are at their worst. It is a very useful device — explained by H. J. Robinson in the ATOMICS section of this issue.

New rewind methods, using silicone material, solved a problem of failure of generator coils for Washington Water Power Co. See Frank E. Garrison's step-by-step explanation, page 91 this issue.

Citric acid is finding more and more industrial applications, not the least of which is as a cleaning agent for power plant equipment. Watch future issues of POWER ENGINEERING for technical details on this usage.

Navy has a new development that bids to replace the transistor in many electronic uses. It's an electrochemical device called the solion, which carries a charge by ions in solution rather than by electrons. Most striking of the solion's characteristics is its very low power requirements — 100 to 1000 times less than that for transistors.

Does cavitation cause feedwater system vibration? Under certain conditions it can, and if it is doing that, two specific things can be done about the situation. See Andre Kovats' article on page 93, this issue.

Power engineers at Westinghouse's East Pittsburgh works have calculated that 1300 man-days per year and 150,000,000 lb of steam per year are saved by using central control equipment for the steam heating system. In the main power plant, adjacent to the switchboard, is a central control panel on which a recording thermometer and 75 push-button control station are mounted. Resistance thermometers, control relays and motor-operated steam valves are located throughout the plant. This system enables one man to patrol and control the entire heating system from a single point.

What Is the Future of

As industry grows, industrial power generation will increase, but total power use will increase more rapidly. Heavier, more concentrated loads will increase size of industrial generating units, thus raise turbine-inlet steam conditions. New units depict this trend

By J. E. McCONNELL*

ELECTRIC POWER generated by industrial plants is on the upward swing, despite the fact that industry will generate a smaller percentage of the total power which they use. Larger, more concentrated loads will bring the application of larger units and justify higher inlet conditions, with associated changes in design.

Reason for this situation is primarily the changing ratio of steam to electrical requirements. In the overall picture, indications are that steam requirements will increase proportionately with the general increase in industrial productivity. Electrical requirements, however, will increase at a higher rate, due to the increased utilization of electric energy per unit of product.

Thus industry finds a growing requirement for more electrical power than can be generated by expanding process steam through a turbine. The balance of electrical requirements must be generated with condensing cycles. As the condensing loads become larger, economics tend to favor the purchase of power where it is available.

Figure 1 illustrates these trends, projected through 1975. It shows that while industrial power generation is expected to rise rapidly, the electricity used will increase at an even greater rate, resulting in a lower percentage of the total being generated by the user.

It should be pointed out that these are figures for industry as a whole, and the picture in individual industries may vary considerably. In the pulp and paper industry, for instance, it is expected that the percentage of power generated will increase. Whereas the figure in 1957 was 62 per cent, it is generally expected to increase to 75 per cent by 1967[1].

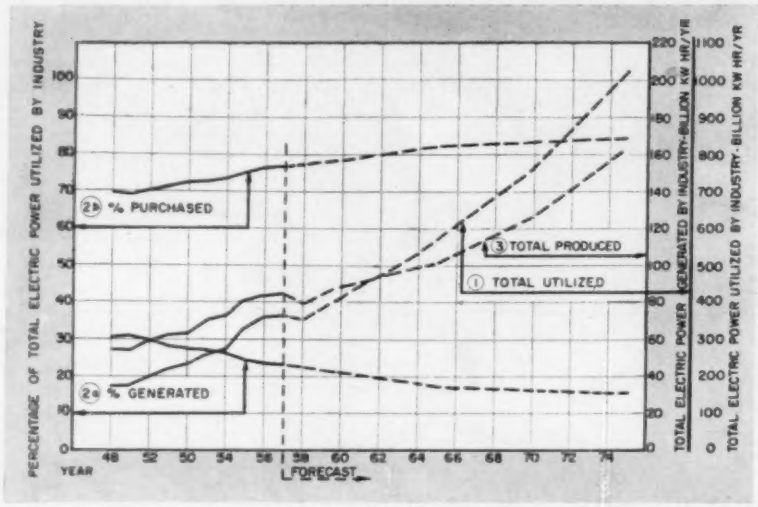
PERCENTAGE OF TOTAL ELECTRIC POWER UTILIZED BY INDUSTRY
TOTAL ELECTRIC POWER GENERATED BY INDUSTRY-BILLION KW HR/YR
TOTAL ELECTRIC POWER UTILIZED BY INDUSTRY-BILLION KW HR/YR
(2) % PURCHASED
(3) TOTAL PRODUCED
(1) TOTAL UTILIZED
(2) % GENERATED
YEAR
FORECAST

Fig. 1. Graphic forecast of the use of electric power by industry, showing the total amount used, and the amount produced by industry itself, and the percentages.

Larger Turbine Generators

Naturally, with increasing industrial power generation, some industries face requirements for larger turbine generators. The larger units permit economical utilization of high inlet conditions.

Three installations indicate typical modifications due to higher inlet conditions. These three units are among the forerunners in the application of 1000-F inlet temperatures in industrial plants.

The turbine shown in Fig. 2 was among the first industrial turbines designed for an inlet temperature of 1000 F. The turbine is a tandem-compound, double-flow design, rated at 50,000 kw, and is designed for inlet conditions of 1250 psig, 1000 F. This unit operates with a five-stage regenerative cycle. The unit went on the line in 1955 to generate power required by the taconite industry in processing a hard iron-bearing rock into agglomerates suitable for blast furnace feed.[2] The process, called taconite benefication, requires 80 to 100 kwh per ton of concentrate.[3] A great percentage of the power is required by giant taconite crushers, rod mills, and electromagnetic separators.

Consideration was given in the design of the turbine to the greater differences in thermal expansion encountered at the higher operating temperatures. The change in the design of components that are exposed to high temperatures can be seen by comparison of steam chests illustrated in Figs. 3 and 4.

Figure 3 shows sections of steam chest and nozzle chambers typical for inlet temperatures as high as 950 F. On this design, the steam chest and nozzle-chamber partitions are cast as an integral part of the turbine-cylinder cover. Steam admission is provided in the base of the cylinder by passages through the horizontal joint, when the additional arc of admission is needed.

Higher Temperatures

Figure 4 illustrates how the steam chest and nozzle chambers are arranged to provide for additional thermal expansion on the higher inlet temperature 50,000-kw turbine. The forged steam chest on the higher temperature design is attached to the outer cylinder by a rigid connector piece, which includes the primary inlet pipe. The second and third inlet pipes are connected to second and third nozzle chambers by flexible connections.

Fourth and fifth inlet pipes, which are the outer inlet pipes, loop down from the steam chest and connect to the fourth and fifth nozzle chambers in the cylinder base. Therefore, all components of the steam chest are provided with excellent flexibility.

*Steam Division, Westinghouse Electric Corp

Industrial Power Generation?

The nozzle chambers are all separate from the turbine cylinder and are free to expand, independent of one another.

The steam chest, separate nozzle chambers, and inlet piping are exposed to 1000-F inlet temperatures and are constructed of one per cent chromium steel. However, the temperature drop across the first stage of blades is sufficient to permit the cylinder to be constructed to one-half per cent chromium material. The cooler leakage steam to the thrust-balancing piston and high-pressure glands passes from the impulse chamber between the separate nozzle chambers and inlet pipes, and thus serves to partially cool the high-temperature components.

Once 1000-F inlet temperatures were introduced into industry, only a short time passed until reheat turbines began to appear. The taconite industry installed one of the first industrial reheat turbines in late 1957. The turbine is rated at 75,000 kw and designed for inlet conditions of 1450 psig, 1000 degrees F, reheating to 1000 F. The unit was also operated with a five-stage regenerative cycle.

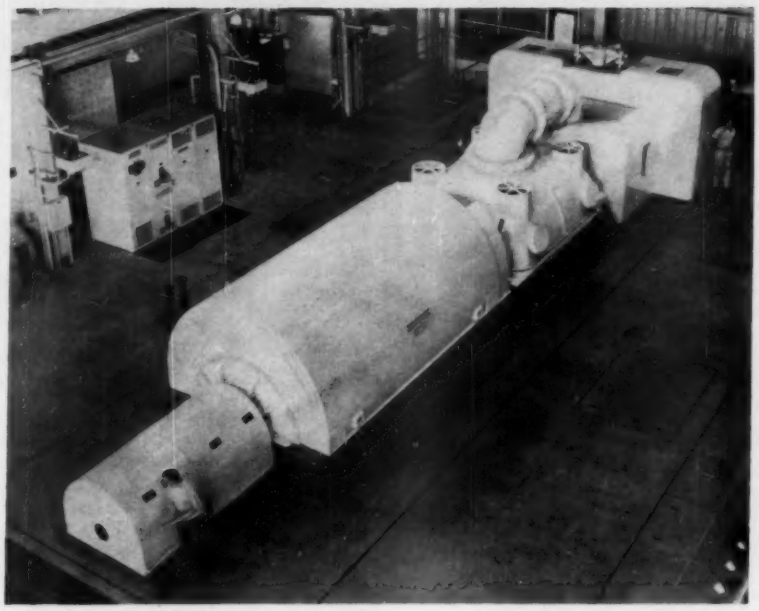

Fig. 2. One of the first industrial 1000-F units, rated at 1250 psig, 50,000 kw

Further Advances

The combined high-pressure and intermediate-pressure turbine incorporates quite a different design from the high temperature elements of the earlier 1000-F turbine. High throttle flow and higher first-stage pressures are the factors that mainly contribute to these differences.

Most striking difference is that the steam chest is no longer mounted directly above the turbine cylinder. Instead, two forged steam chests are mounted separately, one on each side of the turbine. Three flexible inlet pipes, from each steam chest, connect to the outer cylinder, which in turn has provision for flexible connections to each separate nozzle chamber. A cutaway view of one of the separate side-mounted steam chests is illustrated in Fig. 5.

The high-pressure turbine is contained in an inner cylinder. Cooler exhaust steam from the high-pressure turbine passes between the inner and outer cylinder enroute to the openings provided in the center of the cylinder for passage to the boiler for reheating.

A single-cylinder, single-automatic-extraction turbine generator, designed for 1000-F inlet temperature, began to materialize in 1955 when a prominent southwestern engineering firm was retained to construct a large chemical and synthetic-rubber plant, requiring both large blocks of electrical power and large quantities of process steam. The plant, completed late in 1958, is located in an area where fuel costs are extremely high.

Design Problems

After careful analysis, the engineering firm wrote specifications for three condensing, single-automatic-extraction turbine generators. Each was to be rated at approximately 40,000 kw and to be designed for inlet steam conditions of 1650 psig, 1000 F, with automatic extraction at 700 psig. The required throttle flows exceeded 700,000 lbs per hr, and the turbines were to be designed for automatic extraction flows up to 400,000 lbs

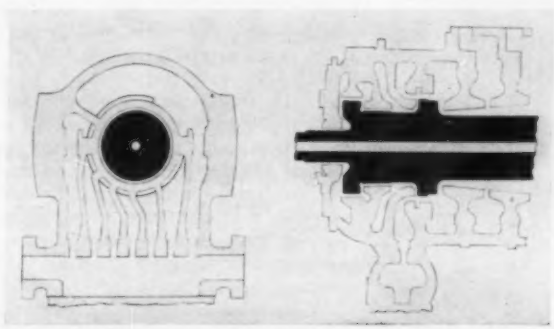

Fig. 3. Sections of steam chest and nozzle chambers showing typical construction for inlet temperatures as high as 950 F

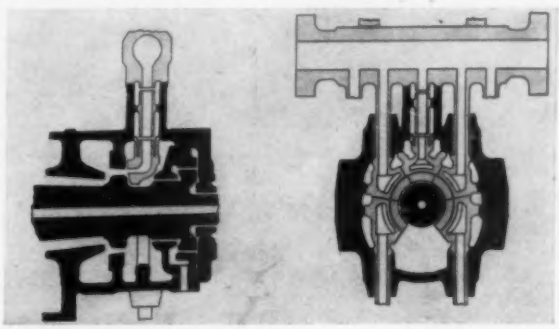

Fig. 4. Section of unit in Fig. 2 shows design alterations needed to allow for expansion and provide internal cooling

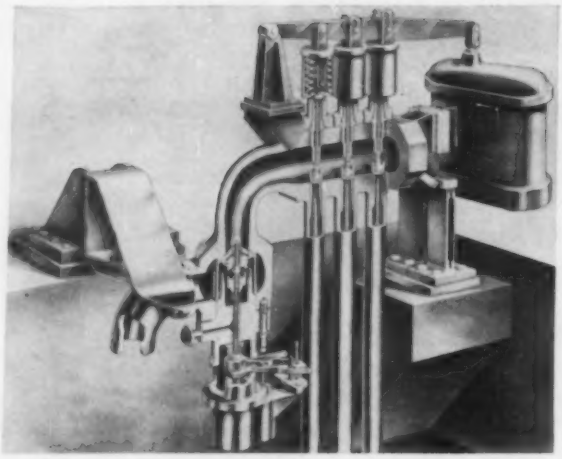

Fig. 5. Typical side-mounted steam chest for large h-p unit

Range of Design Throttle Flows, #/Hr x 10^3	Range of Inlet Pressures, Psig	Range of Inlet Temperatures, F
50– 100	400– 850	600– 825
100– 200	600– 850	750– 900
200– 400	850–1250	825– 950
400– 600	850–1450	900–1000
600– 800	1250–1800	900–1000
800–1000	1450–2000	950–1000
1000–1200	1800–2400	1000–1050

Suggested limits of inlet conditions for mass throttle flows

per hr. In addition to automatic extraction, three non-automatic extraction openings were required to permit a four-stage regenerative cycle.

The design engineer found himself faced with the problem of wrapping up a complete high-temperature design in a single-cylinder turbine, at the same time permitting connection of four extraction pipes to the turbine cylinder. In addition, he was faced with large flows and high pressures. The longitudinal section in Fig. 6 shows how the high-temperature features were incorporated in a single-cylinder design.

Two separate forged steam chests, typical of the larger high-temperature turbines, are mounted on each side of the turbine cylinder with the flexible inlet piping to separate nozzle chambers. The high-pressure section of the turbine is contained in an inner cylinder. The automatic-extraction pressure is controlled by a multivalve, bar-lift, secondary steam chest, mounted above the cylinder cover.

Mass flow cooling principle is incorporated by the passage of automatic extraction steam between the inner and outer cylinder to the front of the turbine cylinder, where it passes from the turbine. The problem of facilitating all the necessary extraction piping beneath the turbine cylinder was aided considerably by having the automatic extraction steam leave the turbine cylinder near the front pedestal.

From the extraction valves to the exhaust, the pressure, temperatures, and flows permitted the use of a typical lower-temperature design with a single-flow exhaust.

Trends in Inlet Conditions

A study of fifteen modern turbine generators with inlet temperatures of 1000 F, installed or under construction for industrial power plants, shows eight of the fifteen are designed for inlet pressures of 1800 psig, and all of the reheat type have ratings ranging from 75 to 125 m. A total of ten units are reheat turbines, all reheating to 1000 F, with the smallest rated at 50 mw. Four of the fifteen are single-automatic extraction units, all condensing and rated at approximately 40 mw.

Inlet conditions higher than 1800 psig, 1000 F, would appear unlikely in the near future for application in industrial power plants. When these conditions are exceeded, it will be for a large non-condensing turbine or a condensing reheat unit, the latter rated over 100 mw. As it now appears, inlet conditions of 1800 psig, 1000 F, are not too practical for a condensing non-reheat turbine, largely due to the high moisture content encountered at the exhaust of the turbine.

Largest factor that contributes to the trend in increasing inlet conditions is the circumstances that permit industry to apply larger turbines, or otherwise use large throttle flows. From the viewpoint of temperature, elaborate turbine designs and costly high-temperature materials are exceedingly hard to justify for small turbines requiring comparatively small mass throttle flow. Exceedingly high pressures also become impractical for relatively small mass throttle flows.

Good turbine efficiency depends largely on reasonable nozzle and blade heights, which may not be obtainable in the control stage of a turbine with low mass flows and very high inlet pressures. In an effort to increase primary nozzle heights, the turbine designer generally finds himself limited to a small number of governor control valves, thus placing heavier than expected penalties on performance at most partial load points.

Because of turbine design considerations, inlet conditions are linked to practical ranges of mass throttle flows. Some correlation has been

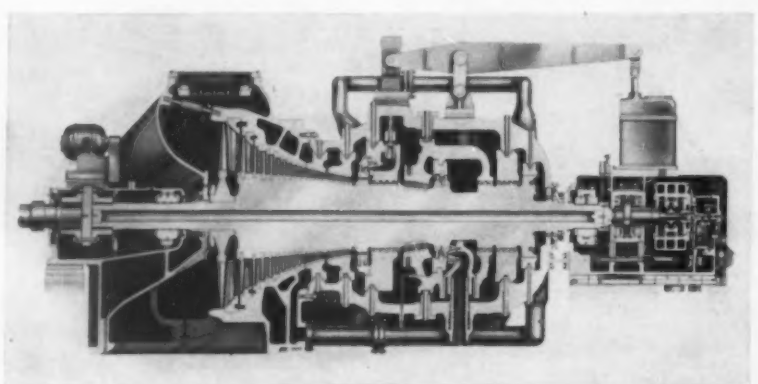

Fig. 6. Longitudinal section of condensing single-automatic-extraction turbine designed for inlet conditions of 1650 psig, 1000 F, and extracting at 700 psig

made in the past to inlet conditions with turbine ratings,[4] but this must be limited to condensing turbines with or without reheat and regenerative cycles. In industrial plants, a much wider ratio exists between design throttle flows and turbine ratings, due to the common application of non-condensing and automatic extraction turbines. Therefore, in the industrial plant, it is much more practical to consider primarily a link between inlet conditions and design throttle flows.

Limiting Factors

For general guidance, what appears to be practical inlet conditions for given throttle flows is presented in the table. It is an effort to link ranges of inlet conditions to ranges of mass throttle flows for all factors of power plant economics.

The tabulation reflects ranges of inlet conditions for ranges of throttle flows that have been predominant during the last few years. Therefore, the information is presented under the assumption that recent economic studies made by the industry for various areas and situations are indicative of practical ranges of inlet conditions and throttle flows. No other refinement is made. Given ranges would have to discount exceptional cases where unusual factors were involved.

It is reasonable to expect rises in fuel costs and other operating costs to closely parallel rises in fixed cost on an industry-wide basis. This would have a tendency to minimize any necessity for adjusting the table to compensate for changes in cost structure.

Whether turbines have reheat or regenerative cycles should not be factors that would cause ranges in the table to be exceeded. Since these factors do effect throttle flow, they can of course result in a slight shift of a plant's position in the tabulation.

Other Considerations

Trends in inlet conditions for industrial plants will continue to be influenced somewhat by many factors that do not normally have to be considered by electric utilities.

Cases occasionally occur where a narrow range of temperature is required for automatic extraction or non-condensing exhaust steam. This is particularly true where steam is extracted to mechanical-drive turbines, or where a non-condensing turbine is used to top lower-pressure turbines. Such cases may reflect on the selection of inlet steam conditions.

Fortunately, most industrial processes requiring steam are condensing processes and can tolerate a considerable amount of superheat. Condensing temperatures are, of course, determined by the steam pressure and not the total temperature of the steam. Consequently, process steam temperatures would reflect little influence on the selection of turbine inlet conditions.

Effort to balance electrical and steam requirements has a degree of influence on the selection of turbine inlet conditions in industrial plants. When a close correlation exists in the electrical power and process steam requirements, industrial power plant designers may shift the available energy between inlet and extraction, or noncondensing points, thus changing flow requirements per unit of electrical power.

Such means are quite generally applied and prove economical for inlet conditions within the limits described in the table. On the other hand, this type of planning may show complete justification for inlet conditions which may appear extremely low. When studies show justification for exceeding low inlet conditions, the final selection would generally be raised to the lower limits of the table under the reasonable assumption that increasing electrical power requirements will eventually bring the system into balance.

By-Product Steam

Availability of by-product steam is a factor that sometimes complicates economic analysis. Production of kraft pulp, for example, offers availability of by-product steam from liquor-burning recovery and bark-burning boilers, where by-product steam may result in over 50 per cent of the total steam required. Thus far, no agreement exists in industry to a uniform method of economically handling by-product steam. Nevertheless, by-product steam is of value, and for the purposes of selecting inlet conditions, by-product steam can be assigned the same rate as steam generated by purchased fuels. THE END

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3. Electrical Equipment for Iron Ore Benefication, B. E. Rector, *Ibid*, July, 1954.
4. Trends in Electric Utility Steam Turbines, S. D. Fulton, *Ibid*, March 8, 1959.

England—France . . . . A New Power Alliance

The French and British power administrations, Electricite de France and the Central Electricity Generating Board, have decided to carry into effect the plan for the exchange of power across the English Channel, which has been under discussion ever since the end of the Second World War.

At the end of 1957, the system developed and proposed by ASEA for high-voltage direct current, which had already been adopted for the transmission of power from the Swedish mainland to the island of Gotland in 1954 — the first and only project of its kind in the world — was officially accepted.

A definite contract has been awarded to ASEA for the principal lectrical equipment for the transmission in either direction of 160,000 kw, equivalent to 800 amp dc at 200 kv. It is anticipated that the installation will be ready for commissioning by the end of 1960.

Idea behind this project is to utilize surplus power from the one country in the other country during periods of peak load. It so happens that the load peaks occur at different times of the day and during different days of the week. In spite of the proximity of the two countries, there are also certain seasonal variations in the load peaks.

In addition, this project will enable both countries to postpone or even refrain from building new power stations, which would entail a considerably greater capital expenditure than the planned d-c link.

The transmission distance will be about 60 km. The converter stations are to be set up in the vicinity of Dungeness in England and Boulogne in France. It is intended to connect the d-c link to the English 275-kv, 50 c/s grid, and to the French 225-kv, 50 c/s grid.

The ASEA d-c system, which was selected in the face of severe competition from other alternative solutions, offers considerable advantages. The number of transmission cables can be limited, the installation costs are lower, and the likelihood of mechanical faults less. Furthermore, the d-c link will enable the network frequency of the one country to be regulated independently of that in the other country, a strong factor in its favor.

How to Choose and Use Your

In the final portion of this three-part article†, types of motors for specific power-plant uses are discussed. Included are circulating-water and condensate-pump motors, various types of induced- and forced-draft motors, and motors for pulverizers and crushers

By R. J. POTTS*

PUMPS SUPPLYING water for the condenser can be either of horizontal or vertical construction. The growing tendency towards outdoor power plants places these motors in a variety of outdoor atmospheres.

To meet the requirements for weather-protected machines, these motors should conform to the NEMA Type II enclosure, as defined in the table. If the vertical motor is used, it is important that the structure be such that two concentric cylinders form the basic construction so that the air intakes and discharge openings are off-set with respect to the inner and outer shell, as in Fig. 1.

These outdoor motors can be provided with removable, washable filters. Effective filters incorporate a corrugated design so that it is impossible for the air containing foreign particles to blow directly through the filter, but must take devious paths.

Outdoor weather-protected motors with filters should have some sort of temperature-detecting device to indicate when the filters should be changed. A thermal, bimetallic strip placed on the stator itself will serve as such an indicator. It is advisable to install space heaters in outdoor enclosures to protect the metallic parts and the insulation, if silicone rubber isn't used on the winding.

Motors driving vertical water pumps usually have to carry downward thrusts consisting of the weight of the pump rotor and shaft, the weight of the motor rotor and shaft, and the hydraulic thrust imposed on the pump impeller. Spherical roller bearings, which are a combination upper guide and thrust bearing, are usually applied on motors having thrusts up to 20,000 pounds.

These spherical roller bearings will normally have lower guide bearings of the antifriction type. The antifriction bearings are relatively inexpensive due to mass production. The friction loss is so low that for most applications, bearing cooling is unnecessary.

Antifriction spherical roller bearings have a minimum life of 100,000 hours. The average life of a bearing is rated five times the minimum life, or 56 years. Antifriction bearings can be used for speeds up to and including 1200 rpm.

When the downward thrust total exceeds 20,000 pounds, the pivoted-shoe Kingsbury thrust bearing is used. These bearings inherently have infinite life and are used in conjunction with upper and lower oil-lubricated sleeve guide bearings.

Small bearings will be self-cooled. The larger sizes necessitate water cooling where very high thrust loads occur. The bearing chamber would contain a cooling coil of copper tubing in which cooling water is pumped through. Kingsbury thrust bearings can be used at speeds as high as 30,000 rpm, and have taken thrusts of 2,000,000 pounds easily and safely.

†See POWER ENGINEERING, Aug., 1959, p. 84, and Sept., 1959, p. 86, for parts I and II.

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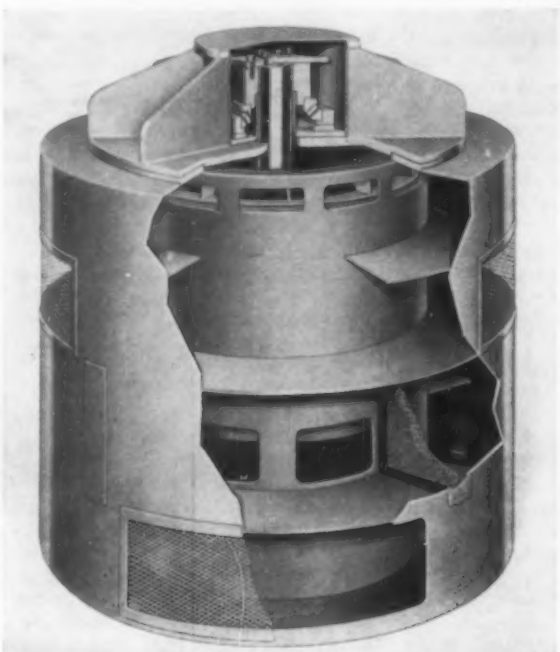


Fig. 1. Cutaway view of vertical motor, outdoor weather protected type. Air makes five right-angle changes in direction

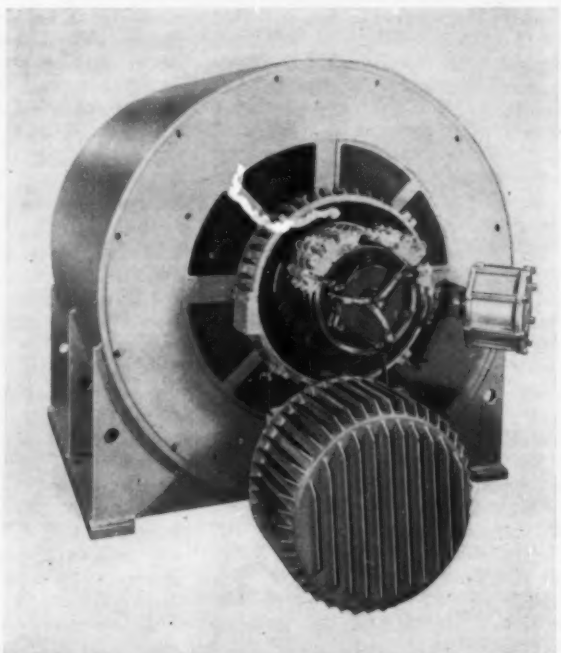


Fig. 2. Wound-rotor motor with collector rings externally-mounted in sealed, finned enclosure, simplifying inspection

Power Plant Motors Properly

In certain instances, vertical motors will use a hollow shaft with the pump shaft running up inside. Connection to the motor is through a coupling at the top of the motor. The coupling can be either the self-releasing type or the rigid type. The "pin-type," self-released coupling is used for hollow shaft motors having downward thrust only. If the motor rotates in the wrong direction due to improper motor-phase connection, a threaded joint in the pump shaft will begin to unscrew, and resulting elongation of the pump shaft raises the upper half of the self-release coupling. This disengages the pump half of the coupling from the motor half.

While this prevents pump shaft reversal due to wrong phase connection to the motor, it does not prevent reversal of motor due to turbining of pump impeller and shaft. To prevent the motor from turbining, a non-reverse ratchet is used in conjunction with the rigid coupling.

Different forms of non-reverse devices (back-stops) are used. A typical arrangement consists of pivoted shoes which, when the motor is turning in the right direction, will slide along a stationary drum during start and will disengage at operating speed due to flyball action. If incorrect rotation is attempted, the shoe will engage the stationary drum, prohibiting rotation.

Necessary Protection

The back-stop has use in protecting circulating-water-pump motors. If the motor and pump are allowed to rotate in the opposite direction due to a hydraulic head, a speed of 125 per cent or more can be encountered. Although the normal motor can withstand 125 per cent reverse speed, significantly higher speeds will take them out of the guarantee of the motor manufacturer unless the manufacturer designs this high overspeed into his motor.

Not only will mechanical overspeed affect the motor, but if the motor is energized while it is running at 100 per cent speed in the reversed direction, at least four times the heat dissipated in the rotor winding during a normal start will be produced when bringing the motor up to full speed from full-speed reverse. It is necessary that the backstop be of adequate design and is capable of taking the reverse hydraulic torque imposed on the motor at standstill.

It is characteristic of induced-draft fans and forced-draft fans to be operating in an outdoor ambient which is saturated with fly ash and other destructive foreign materials in the air.

Fly ash, being a very penetrating dust-like substance, works its way into the smallest crevices and is very difficult to guard against. The abrasive qualities of fly ash are such that it is considered even more penetrating than sand. When mixed with moisture, the fly ash can form a paste-like material, which in due time can harden in vital air passages in the motor. Methods of preventing fly ash from deteriorating a motor have always been sought.

The totally-enclosed, fan-cooled motor has been an effective way of limiting foreign particles inside the motor. In very extreme cases where the fly ash concentration is unusually high, the totally enclosed, fan-cooled motor may be applied.

Its younger brother, the outdoor weather-protected motor, Fig. 3, has won greater popularity because of the protection this enclosure gives the working parts of the motor, and yet it is considerably less expensive.

Open motors are also being applied for induced-draft fan and forced-draft fan motors. In these instances, of course, high-grade insulation should be used to protect the motor from failure due to abrasion.

One big advantage the open motor and the outdoor weather-protected have over the totally-enclosed, fan-cooled motor is that it has a load-service factor. With exhaust conditions changing, such as gas pressures and temperatures, the horsepower requirements at full load can fluctuate. The motor with the service factor is in a better position to handle these fluctuations.

Use of Wound-Rotor Motors

One of the main functions of draft-fans is to change air cfm to compensate for different loads imposed upon the boiler. Draft fans can be controlled in speed by vane control, magnetic couplings, hydraulic couplings, and by wound-rotor motors.

Although a speed range of from 30 per cent to 100 per cent is quite demanding, speeds throughout this range can be attained when the wound-rotor motor is used in conjunction with a high-grade liquid-slip rheostat. The problem of proper ventilation increases at lower speeds, but since the horsepower requirements vary as the cube of the speed in a fan load, the motor can produce enough cooling at the 30 per cent speed point.

The wound-rotor motor and the liquid-slip rheostat offer the advantage of a high degree of control. If the wound-rotor motor is used, a most practical way of enclosing the collector rings is by using a finned enclosure, external to the machine. Not only can the rings be inspected easier and maintenance minimized,

List of NEMA Requirements

NEMA Type I: A weather-protected machine—Type I is an open machine with its ventilating passage so constructed as to minimize the entrance of rain, snow, and air-borne particles to the electric parts and having its ventilating openings so constructed as to prevent the passage of a cylindrical rod ¾ inch in diameter.

NEMA Type II: A weather-protected machine—Type II shall have, in addition to the enclosure defined for a weather-protected machine—Type I, its ventilating passage at both intake and discharge so arranged that high-velocity air and air-borne particles blown into the machine by storms or high winds can be discharged without entering the internal ventilating passages leading directly to the electric parts of the machine itself. The normal path of the ventilating air which enters the electric parts of the machine shall be arranged by baffling or separate housings as to provide at least three abrupt changes in direction, none of which shall be less than 90. In addition, an area of low velocity, not exceeding 600 ft per minute, shall be provided in the intake air path to minimize the possibility of moisture or dirt being carried into the electric parts of the machine.

but 100 per cent sealing of slip rings from the elements is achieved.

If a wound-rotor motor is used to drive draft fans, no particular attention is paid to the problem of accelerating high-inertia loads. When direct-connected induction cage motors are driving the fans, however, definite caution must be used. Of the electrical energy put into an induction motor while starting a high Wk^2 fan load, approximately one-half of the energy is stored as kinetic energy in the rotating fan, and one-half of the energy is dissipated as heat in the rotor of the motor.

A motor can never be effectively applied unless the actual inertia of the flywheel (fan) is known. A violation of the manufacturer's starting restrictions on fan motors can result in breakdown of the motor — due to overheating in the rotor. During the alignment of the fan at installation, it is not uncommon to have operators jog the motor repeatedly in order to balance the fans. This procedure can quickly bring trouble.

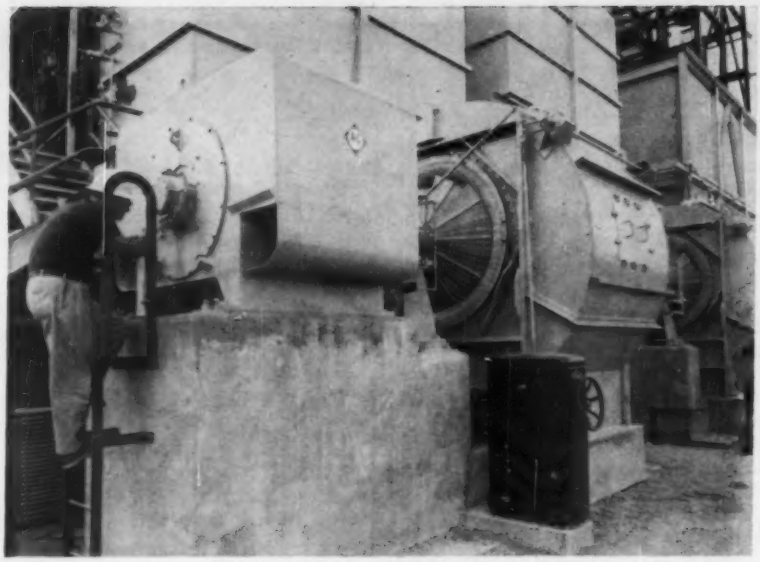


Fig. 3. A 700-hp weather-protected induction motor, driving a forced-draft fan

More starting capability (more heating capability) can be built into the motor by designing the rotor with more mass, such as providing more pounds of copper in the end ring. The special-design motor, however, still has its limitations and these must be observed. The number of permissible starts actually depends upon the time required to accelerate the load from standstill to full speed, the thermal capacity of the motor, and the time required for the motor temperature to return to rated temperature after each such start.

Various kinds of crushers and pulverizers exist on the market, and their basic performances are different. It is possible to get units which have high Wk^2 values and 100 per cent starting torque, or they might have 200 per cent starting torques and normal Wk^2 values.

Most pulverizers and crushers are started unloaded, but in the event of a fault, and a subsequent rapid bus transfer, the pulverizer or crusher reduces its speed along with other auxiliaries on the system. This being the case, these loads might have to reaccelerate under low-voltage conditions, due to high reacceleration currents. The 200 per cent breakaway torque would help the loaded pulverizer accelerate its load, even though the voltage is only around 70 per cent.

In the other case, the pulverizers which require approximately 100 per cent torque utilize arms that fly out due to centrifugal force at a specified speed. Below this speed, the torque requirement of the load pulverizer is not great, and low voltage might not be as critical a problem.

Important thing to remember when applying pulverizer and crusher motors is that a complete understanding of the driven equipment is necessary. Absence of this information not only leads to confusion, but can result in misapplying a motor. THE END

Low-Temperature Process-Heat Reactor

THE ATOMIC Energy Commission has selected, as the basis for contract negotiations, the proposal of Sargent and Lundy for performance of architect-engineering services for an experimental low-temperature process heat reactor.

Proposed reactor would be a pressurized-water type, designed to produce approximately 40,000 kw of heat, and would be constructed at a site yet to be determined. Congress authorized the project in June.

A process-heat reactor is one designed to produce heat for industrial operations rather than for the production of electricity. It is anticipated that process-heat reactors can be used in many manufacturing industries, such as those engaged in the production of primary metals, glass, cement, and petroleum, coal, chemical, food, petro-chemical, and paper products.

In addition, these reactors may be developed for the generation of heat for saline water conversion. The Department of the Interior has asked the Commission to coöperate in the Department's Office of Saline Water demonstration plant program by building a reactor in conjunction with a sea water distillation plant to be located on the west coast.

Major goals in developing process heat reactors are the reduction of costs of future process heat plants and the achievement of a high degree of operating reliability. These goals might be reached through the use of inexpensive materials and, to a large extent, simple standard components which would be made possible through the use of reactors with low operating temperatures and pressures.

Possible advantages of nuclear process heat over conventional heat include elimination of the discharge of smoke and waste gases to the atmosphere, reduction in space required for conventional fuel inventory storage, infrequent refueling periods, location of plant independently of its relation to its fuel source, use of nuclear irradiation for isotope production and production of plutonium as a by-product.

Editor's Note: In the ATOMICS section of POWER ENGINEERING, June, 1959, a comprehensive discussion of this subject appeared. (See Nuclear Energy for Process and Space Heat in the United States, by Paul L. Geiringer and Morton J. Goodfriend, page 56.)

This AEC contract represents a major implementation of this application of atomic energy.

Using Ladders for Cable Supports Saves $187,500 at Portland

In addition to these spectacular savings, other advantages inherent in this system are flexibility, accessibility, low maintenance

By EDWARD M. DAVIS*

METROPOLITAN EDISON Company's new generating station at Portland, Pa, went into full commercial operation in September. Since it is one of the first stations to use a new type of cable-supporting system — aluminum ladder, others may be interested in our experience with it. Such a system has many advantages, and substantial savings result.

Since the traditional system for power cable support is conduit, let me first explain why it was decided to avoid the use of conduit as much as possible. As generating stations grow larger, power cable in conduit becomes more and more of a problem.

With most of the major electrical equipment in the basement, a high percentage of the conduit is installed in the space between the foundation slab and the finished basement floor. However, more and larger cables, more drain lines, ash lines, and so on make design and installation so involved that the underfloor conduit system becomes impractical.

Moreover, conduit in concrete never was thoroughly satisfactory. The cables were, in many instances, buried forever. In the event of cable failure from fire or arcing, both cable and conduit were frequently lost since, under these circumstances, it usually is not possible to withdraw the cable.

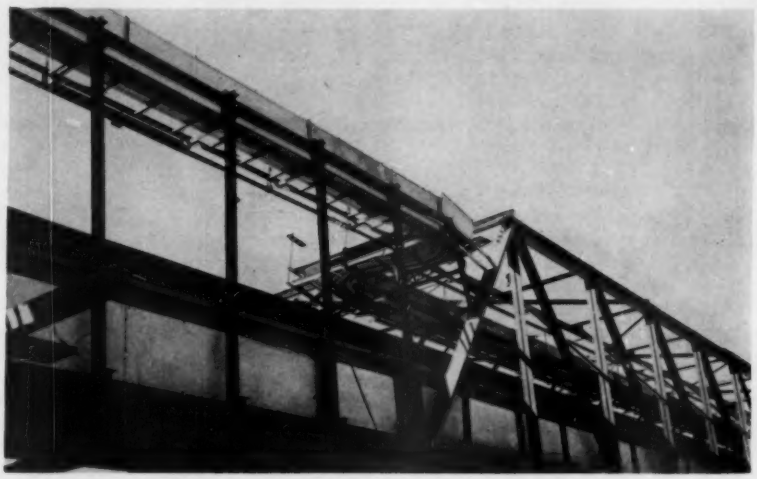


Fig. 1. This close-up of a section of the coal conveyor shows the aluminum cable ladder supporting armored cables for power and control of coal-handling system

Other Factors

Furthermore, provision for equipment additions to the stations was scarcely possible since positive assurance of the exact location and size of the future service was not available. Costs prohibited the installation of extra conduit during construction to provide for later additions, and the costs of digging up concrete to lay new conduit were prohibitive.

Because of the ever-increasing amount of space required by conduit and the problems of interferences, another way of routing the cables was adopted. We used trenches in the basement floor, in which cable were laid directly on concrete and protected by solid-steel removable covers. However, this system required heavy grounding shields for the cables, and severe derating factors. Consequently, cable costs were increased by 40 per cent. Even worse than the added capital outlay for cables was the damage to cable insulation that would occur if acid, chemicals, or the like, were to enter the cable trench because of an accidental spillage on the floor in a nearby area.

Underground seepage also was a problem. I know of one station where cables installed in conduit in solid concrete were ruined by effluent from a chemical plant upstream. Without conduit, they are, of course, still more exposed.

In an effort to avoid the pitfalls of cable installed in the concrete slab, the Metropolitan Edison Co engineers asked us to keep all cable out of the basement floor. With the introduction of new designs of cable trays and ladders, we discussed this possibility with the Metropolitan Edison Co engineers, and agreed that the method should be considered for the Portland Station.

From past experience we knew that an overhead power cable system would be difficult to design because of the myriad assortment of pipes in this same area, and we tackled this assignment with no little concern. It can now be reported that the relatively few interferences discovered by the construction forces prove the feasibility of overhead cable systems in trays and ladders, but not without careful coördination between the various groups of designers working on the project.

Conduit vs Cable Ladder

There were two methods we considered: neoprene sheath cables in conduit and interlocked armored cable in cable ladder. Either way, oil-base compound insulation was agreed upon. The cable costs for cables of comparable size were about the same — the interlocked armored cable was slightly lower.

Cost factors, therefore, reduced themselves to the difference in cost between conduit and cable ladder. (Costs of conduit supports and ladder supports are ignored, but probably

Editor's Note: Portland Station is one of the country's important new stations. It was described in considerable detail in an article in POWER ENGINEERING in January, 1958, "Monotube Boiler, Axial-Flow-Exhaust Turbine Make Unique Combination." In addition to major innovations, however, there are a number of other features which make Portland outstanding. One of them is described in this article.

*Electrical Engineer, Gilbert Associates, Inc

ladder supports are less because the ladder, in general, is lighter.)

Difference between the two methods considered is astonishing. There is a tremendous labor saving when cable ladder is used.

Portland Station has approximately 10,000 ft of ladder and 100,000 ft of interlocked armored cable for power circuits. Approximately 80,000 ft of this cable was installed on ladders, an average of eight cables per ft of ladder. Both 600-v and 5-kv cables were installed on ladders. The cables are three-conductor and range in size from 750 mcm to No. 10, with outside diameters ranging from 3.25 in. to 0.88 in.

Comparative Costs

If these cables had been installed in conduit, the average conduit size would have been 2 in. Based upon labor costs for other stations, the average cost of the conduit installation, including bends and fittings, would have been $2 per ft. The total cost of installing 80,000 ft of conduit would have been $160,000.

The cost of installing the 10,000 ft of ladder was $33,000 or $3.30 per ft. The ladder ranged in widths from 3 in. to 24 in., so the $3.30 figure is an average cost for all widths. Since there was an average of 8 cables per foot of ladder, the installation cost per cable ft in ladder is about $0.41, roughly 20 per cent of the installation cost per cable foot when in conduit.

Since these savings relate to labor alone, they may seem to be exaggerated. The savings are more understandable when it is remembered that each conduit supports only one cable — each cable ladder supports an average of eight cables.

There is one other labor cost which must be factored into this comparison. Most contractors are quoting prices for cables installed in ladder approximately 20 per cent higher than for cable installed in conduit. It probably does require a little more time to pull a cable along a ladder and then clamp it securely than to pull the cable through a conduit. Using a difference of 20 per cent, the power cable installation cost would have been $7,000 less if the cable had been conduit, but the total savings in labor still amounted to $120,000.

With 80,000 ft of cables supported in only 10,000 ft of ladder, there is an obvious materials saving. If ladder had not been used, 80,000 ft of 2-in. conduit would have been required. We paid approximately $1.70 per ft of ladder — $0.21 per cable ft. The cost per foot of straight sections of 2-in. conduit is $0.46, and the fittings would increase the cost per ft. If any event, if we had used conduit, the material cost would have been more than double the total cost of the ladder.

Derating Factor

Interlocked armored cables, 5-kv, 3/c, 500-mcm, installed on ladder, were used for the main 4160-v feeds from the station-service transformers

Table I. Tabulation of the actual savings using cable ladder rather than conduit

	Cable Ladder	Conduit	Saving, %	Savings at Portland
Material Installation Costs per cable ft	$ .41	$2.00	79%	$127,000
Cable Installation Costs per cable ft	.45	.36 (–)	20%	7,000
Material Costs per cable ft	.21	.50 (est.)	58%	23,000
Power Cable Costs, 500 mcm vs 750 mcm per ft	6.40	9.01	29%	19,500
Structural Savings (by not putting conduit in slab) Cost/yard		25.00		25,000
				$187,500

Fig. 2. Five tiers of cable supported by aluminum ladders go overhead in dramatic demonstration of space-saving feature

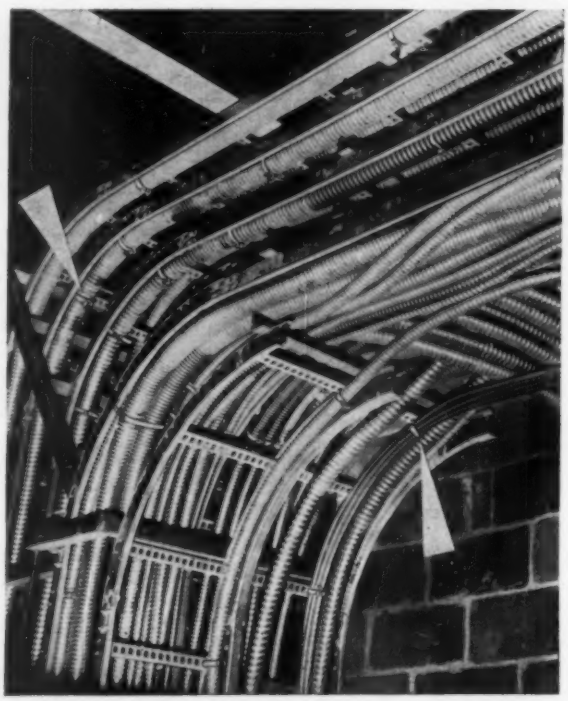


Fig. 3. A close view of the cable ladders shows "Z" configuration of the cross-section, and the use of cable clamps

to the switchgear. The space between cables was slightly more than one cable diameter. Had neoprene sheath cables on conduit been used, the derating factor would have required 750-mcm cables to carry the same load (see Table II). We used 7500 ft of 500-mcm cable for prime power distribution. The use of 750-mcm cable in conduit for these circuits would have cost an additional $2.61 per ft. Savings of $19,500 in cable costs were effected by using ladder that allows higher ampere ratings for a given cable size.

When conduit is eliminated in the basement slab, it may be possible to reduce the thickness of the slab. Given a station 150 ft square, and with a reduction in the slab thickness of only one ft, there is a saving of roughly 1000 yd of excavation and fill. At a cost of $25 a yd, there is a saving there of $25,000. Moreover, the reduced weight of the slab could mean fewer piles and reduced costs in construction of the foundation. Of course, this assumes that structural considerations, such as uplift, and material considerations, such as building drain lines, ash lines, etc, permit such a reduction.

Power circuits for smaller loads can be piled in open wireway. The same circuits in conduit would require more space, space that must be translated into construction dollars for a larger station. A second type of space saving results from the built-in extra capacity of a cable ladder system. Expansion at a later date becomes a simple matter because new cables can be laid in existing supports. If major expansion plans develop, new ladder can be easily added. New fittings can be added to existing supports to tie in the new circuits at minimum cost.

Why Aluminum

Metropolitan Edison selected aluminum rather than galvanized steel cable ladder for two reasons. First, aluminum interlocked armored cable was being used, and galvanic action can take place between aluminum and steel. We realize, of course, that there would be no galvanic action between aluminum and the single coating of galvanizing, but it is possible that some galvanizing might be removed during construction, thus leaving bare steel. In this event, galvanic action would occur.

Second reason for using aluminum is to eliminate the need for painting. Although unpainted galvanized steel cable trough or cable ladder is often acceptable, the company felt that eventually they would have painted it. Therefore, although galvanized steel cable ladder is even less expensive than aluminum cable ladder — about 25 per cent, the difference in installed cost is not as great because the expense of painting all 10,000 ft is eliminated. Erection costs also were reduced considerably because aluminum is lighter and more readily handled than steel.

All the cable ladder used in this station was supplied by T. J. Cope Div, Rome Cable Corp. The particular design of this ladder is quite favorable structurally, due to the method of fastening the rungs to the "Z" sections which form the sides of the ladders. In this design the weight on the rungs is transferred to the deep side of the "Z" shaped side members which, we feel, is preferable to supporting the weight from the bottom flanges of the side members. This feature is particularly advantageous when the ladder material is aluminum.

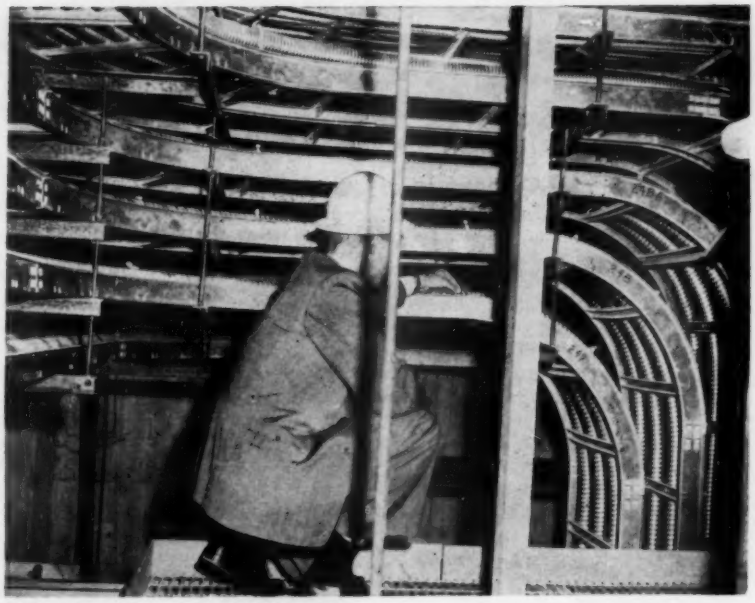


Fig. 4. Flexibility of cable ladders becomes apparent in these cramped quarters

Fastening Cables

Method of securing the cables to the ladder is an interesting sidelight. The larger power cables had to be carefully spaced from each other so that the full free-air cable ratings could be obtained. Also, all cables were clamped to the ladder at regular intervals in horizontal as well as vertical runs.

Initially we thought that we would use marline to secure the cables until we discovered that a convenient and inexpensive band is available from the supplier of the ladders.

Use of this band to clamp the cables provided a much neater and stronger banding of the cables than would otherwise have been possible. In fact, these cable clamps were liked so much by the construction forces and were so easy to use that we ended up by tripling our original order for them after they had been given a thorough trial.

Summarizing the many comments from all concerned, it was the unanimous opinion that the use of aluminum supports for power cable resulted in a highly-desirable installation. These supports provide a strong, neat, and space-saving method of distributing power circuits at a very substantial saving over more conventional systems. THE END

Table II. Comparison of the current-carrying capacity of the two types of cable

Cable Size AWG—MCM	3/C Interlocked Armored Cable Amperes per Conductor Free-Air Rating in Cable Ladder	3/C Neoprene Sheath Cable Amperes per Conductor Exposed Conduit Rating
750	480	389
500	374	307
250	245	201
4/0	221	181
1/0	147	120
2	113	93

How to Select and Maintain Your Air Compressors

Some knowledge of air compressors is required by all power engineers. This is the second part of an article dealing with compressed air. First part concerned principles and types of compressors; this section relates to their selection, application and maintenance

TO INTELLIGENTLY SELECT an air compressor, at least three factors should be understood by the individual making the selection: 1. some insight into the technical aspects of the situation must be acquired; 2. both present and future needs (to which the compressor will be applied) must be either known, or accurately estimated; and 3. new applications of compressed air, that might affect the first two factors named above, must be considered.

Substantial benefits in monetary savings and increased production can result from the properly planned use of a compressed-air system, the heart of which is the compressor. Because it is an unseen and silent source of power, air is often taken for granted. It is, however, a powerful ally for those who analyze it carefully and use it wisely. The capacity and type of the compressor selected depends, of course, on the nature of the task it is to perform.

Air compressors may be broadly grouped into three classifications, according to the type of operating conditions encountered:

1. Intermittent, in which the demand for air is varied and infrequent — a start-stop condition. (This kind of operation should not be utilized if demand exceeds one-half of the air compressor's capacity.)

2. Continuous, in which the demand for air is steady, regular, and usually exceeds one-half of the air compressor's capacity.

3. Combined, in which both intermittent and continuous operating conditions are encountered. This type is especially well-suited to situations where there is a heavy demand for air during the day (continuous operation), and a light (or infrequent) demand at night and on weekends.

The choice between single- and two-stage compression depends on such factors as size of cylinders, speed, compression-ratio, discharge-temperature, power cost, use, cooling-medium, and type of installation. In general, the choice between a single- and a two-stage double-acting compressor may be made from the following criteria (assuming intake air at sea-level atmospheric conditions):

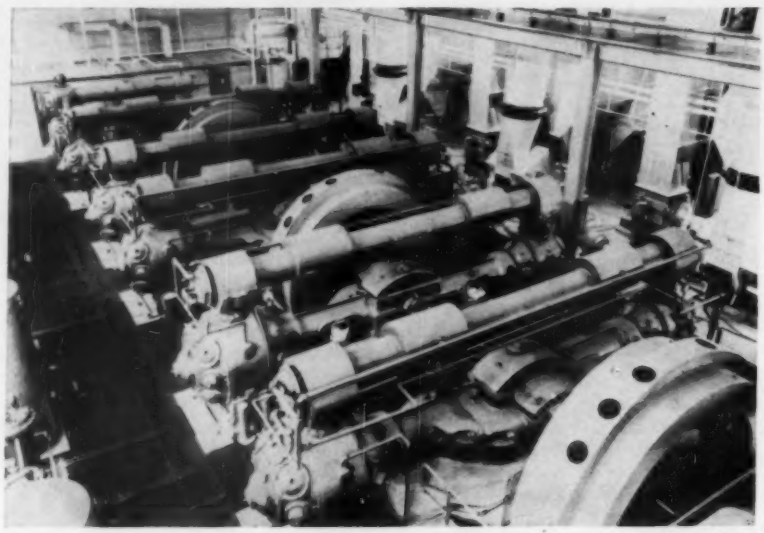


Fig. 1. Battery of Ingersoll-Rand 8000-cfm, 100-psi air compressors, installed in Ford plant, Sterling Twp., Michigan. Installation made by Dravo Corp, Pittsburgh

1. For pressure less than 60 psi, single-stage.

2. For pressures between 60 and 100 psi, single-stage for capacities less than 300 cfm, and two-stage above 300 cfm.

3. For pressures above 100 psi, two-stage.

Centrifugal vs Reciprocating

Desired volume of air may dictate the use of centrifugal, rather than a reciprocating, compressor. Large volume does not, of itself, mean selection of the centrifugal unit, but it does signify that serious consideration must be given to both types.

A final possibility must also not be overlooked: some compression problems may best be solved by a combination of reciprocating and centrifugal machines.

In any event, the various factors of initial cost, kind of driver, power source, maintenance, and installation cost will determine the choice of compressor.

In determining air compressor requirements for any given installation, a choice must be made between a central stationary source of supply and a decentralized operation. Supervisory personnel, in some fields, have found that the central, or fixed, source of air is costly and lacking in flexibility. As an example, if a central system suffers a breakdown, the entire plant will be without compressed air. With compressors in a decentralized system, however, the repair operation is localized and work can continue in other parts of the plant.

Decentralizing appears to be the answer in many instances and ordinarily means the location of a number of air compressors at strategic points in the various work areas. Such a set-up is particularly applicable to operations where a considerable number of portable air tools are distributed over a large area.

Generally considered to be the advantages of a decentralized (over central) air compressor system are:

1. Reduces the number of joints and outlets (decrease in leakage).

2. Increases flexibility (air compressors may be installed, or removed, as needs indicate; relocation

of air compressors is possible without great expense).

3. Eliminates long lines (decrease in leakage and friction).

4. Decreases work stoppages (breakdowns and periodic overhaul operations are localized).

5. Reduces operating costs (no need exists to produce pressures beyond existing requirements; i.e., the air compressor is used as needs require).

In order to determine the volume of air required, and the pressure range of the air compressor, the requirements of each air-operated device to be used must be determined. The compressor selected must be capable of maintaining the minimum pressure of the tool with the highest rating; it also must be capable of producing the total volume of free air required. In addition, provision should be made for expanded use of compressed air over the expected life period of the compressor.

Let us assume that a small plant has determined that the sum of its free air requirements is 75 cfm, with pressures varying from 70 to 170 psi. A 7.5-hp, two-stage compressor would meet the plant's needs. Additional compressor capacity of 35 per cent is considered adequate for expanded use. The free air requirement would then be 75 plus 35 per cent of 75, or 101 cfm. An adequate compressor would therefore probably be a 10-hp, two-stage unit. Tabulation below lists some typical compressor ratings and applications.

Three general rules may be stated as summing up care and maintenance of compressors: 1. inspect at regular intervals; 2. lubricate properly; and 3. follow recommended procedures.

Inspections are usually performed for two purposes: to determine which parts are worn or in need of repair or cleaning, and to ascertain future repair procedures and repair parts needed. The inspection of rotating machinery at prescribed intervals is essential, the frequency of inspection being determined by the environment in which the machine operates. The best general rule is to follow the manufacturer's service manual, as amended by the user's experience and special local environmental conditions of operation.

A thorough and complete inspection of the air compressor should be made at regular intervals and appropriate records of the inspection made. Check-lists and inspection records need not be elaborate, but they are valuable tools in initiating and keeping a log of maintenance operations. At the time of periodic inspections, necessary corrective action may be taken, including replacement of worn packing, cleaning of air valves, replacement of worn parts, cleaning of crankcase, and adjusting for the normal wear of working parts.

Compressor crankcases must be drained and refilled with clean oil at regular intervals. Before refilling, however, the crankcase should be thoroughly cleaned and, in aggravated cases, flushed with oil. (Never with gasoline or other flammable fluid.) Water jackets should also be checked regularly, and cleaned or scoured as required.

Lubrication of an air compressor is probably the single most important step in its care and maintenance. Lack of adequate and properly-timed lubrication will result in damage to many parts. And, the choice of a poor grade of lubricant — even though properly applied at timely intervals — will result in shortened compressor life and decreased efficiency. It should therefore be a cardinal rule of air compressor care that only a high-grade lubricant (that meets the compressor manufacturer's specifications) be used, and that it be used as prescribed.

The manufacturers of air compressors specify fundamental characteristics of lubricants to use under varying conditions of service, including flash and pour points and viscosity. Compressors may require as many as three types of oil for bearings and crankcase, compressor cylinder, and power cylinders. Single-acting compressors require an oil suitable for both cylinder and crankcase lubrication, known as *compressor-cylinder*

Why This Article

Practically all fields of power engineering involve some use of compressed air. Present use of controls which are air-operated, plus increasingly wider use of compressed air, create heavy demands on this vital power service.

Air compressors are built to give many years of trouble-free operation, provided they are properly selected and well-maintained. With this in mind, we have presented some of the basic principles of selection, application and maintenance.

Compressed air is not free, and should be conserved, the same as any other power service.

Table at the right shows standard ratings of conventional compressors — reciprocating, rotary, centrifugal, and axial

TYPE OF COMPRESSOR	Hp	Press., psig	Cfm
Reciprocating			
Single & 2-stage	1/3–20	50–250	1.93–95
2 Stage, Single Acting	15–125	125	81–641
1 Cyl., 1-Stage, double-acting	15–75	20–150	96–939
2 " 2 " " "	60–150	125	368–978
4 " 2 " " "	175–600	125	1186–3896
4 " 2 " " "	350–1250	80–125	2418–6048
Rotary			
Sliding-Vane type	—	125	5300
1-Stage, two-impeller	—	10	50,000
Centrifugal			
Single-stage	—	1–7	500–100,000
Multi-stage	—	—	150,000
Axial			
Single-stage	—	1–3	5000–100,000
Multi-stage	—	—	2,000,000

Fig. 2. Portable unit, consisting of gas engine, compressor, starter and controls. Photo courtesy of Joy Manufacturing Co

oil. Double-acting units may use compression-cylinder oil for cylinder lubrication and crankcase oil for frame running gear. Care should be exercised to insure that the compressor manufacturer's recommendations are followed, and that the lubricant manufacturer guarantees his product as satisfactory for the intended use.

Compressor manufacturers ordinarily furnish with each unit a manual of installation, operation, and maintenance instructions. These publications should be thoroughly read and understood by both operators and maintenance personnel.

Since maintenance is tied to operation of an air compressor, preventive maintenance includes proper starting; operation and stopping of the unit; keeping it clean inside and out; and (if it is turbine-driven) insuring that steam is dry, neutral, and free of carryover of water and boiler compound. While an air compressor is in operation, lubricating oil must be tested to insure that it is clean, free from water, and of the proper viscosity.

The inspection of any piece of rotating machinery, at definite, prescribed intervals, is essential to the effective operation and economical life of the machine. The frequency of these inspections, while they may be estimated by the manufacturer of the air compressor, can usually be best determined by the local user, based on the manufacturer's recommendations.

In order to properly maintain an air compressor, and to insure its continued operation during regular working hours, an adequate stock of expendable spare parts (based on the manufacturer's recommendations as modified by local operating conditions) is essential. Ordinarily, this supply will not tie up a large sum for the average owner.

Air compressors are relatively maintenance-free, and the cost of spares is nominal. The main point is to be prepared for emergencies that occur whenever machines are used. The extent to which spares are justified will depend on the value of downtime and the degree of wear expected. Basic, normal wearing items such as packing and bearing liners should be on hand at all times.

Portable Compressors

Portable air compressors have enjoyed increasing use in recent years, in sizes to about 800 cfm, and should not be omitted from a general discussion of compressors. A portable air compressor is a self-contained supplier of compressed air, and usually consists of a compressor, prime mover, and air receiver — complete with cooling, lubricating, regulating, and starting systems. The compressor may be either the rotary or reciprocating type; and, if the latter, of single- or two-stage design, usually with single-acting cylinders.

Generally air-cooled, these units may be powered by a multi-cylinder, four-cycle gasoline, or two- or four-cycle diesel engine, or by an electric motor.

The entire arrangement is usually mounted on a metal frame and protected from the weather by a roof and movable siding. The portable compressor, therefore, is a complete air compressor plant that is sufficiently light in weight to be easily moved and yet strong enough to withstand the rigors of outdoor movement. Figure 2 is a photo of a typical portable compressor.

Portable units may be mounted in a variety of ways — steel wheels, trailers, truck chassis, railway cars, skids, pneumatic tires, mine car, and tractor. A portable compressor should be located where incoming air is as clean as operating conditions permit, and in a level position.

Portable compressors are no different than larger and permanently-installed units, in that they also require regular maintenance according to a careful plan. The same general rules apply to portable units as are applicable to stationary units.

Manufacturers furnish instruction manuals that should be carefully checked and understood by personnel who will operate the air compressor. In general, the entire unit should be inspected at least after every 300 hours of operation.

Summarizing, we find that:

1. Air compressors depend on Boyle's law and, preceded by the familiar blacksmith's bellows, generally take air (or gas) at atmospheric pressure and push it to a higher pressure.

2. Compressors are of four main types: reciprocating, rotary, centrifugal, and axial — each having its own special ratings and applications.

3. Choice of type, or rating within a type, of compressor depends on the job to be done or the operating conditions to be encountered.

4. Compressor maintenance is founded on three general rules: inspection, lubrication, and following the procedure laid down by the manufacturer, as they are amended by local considerations.

Editor's note: Subsequent articles will discuss compressor drives, accessories and preventive maintenance. Watch for this series. THE END

Coal Has Its Day In Congress

IN A major speech endorsing legislative proposals for a national fuels policy, Senator Thruston B. Morton of Kentucky said that the coal industry not only has withstood inflationary trends, but still stood as a major weapon in the American arsenal for security and industrial progress.

The Kentucky Senator, in his Senate speech, lauded the coal industry leadership, both labor and management, for vision in surpassing the world in the efficient production of solid fuels. American coal can now undersell competitive production anywhere on the globe, provided there are no political or other artificial discriminatory barriers, Senator Morton declared.

Warning that the country would have to rely most heavily on the production and transportation of vast tonnages of coal in the event of war or other emergency, Senator Morton urged enactment of legislation to bolster the $5 billion coal industry, which has sagged in employment, dollar-value, and profits since its peak year of 1947.

Among other points stressed by the Kentucky Senator were these:

1. While the American coal miners' wages have increased on an average from $1.94 an hour to $3.26 in the last decade, making him the highest paid industrial worker, the price of coal at the mine has advanced from $4.99 to $5.00 a ton during that period.

2. Coal industry has increased per-man productivity from less than 5 tons a day to almost 12 tons per man per shift.

3. It is supplying 68 per cent of the fuel used by steam electric-generating plants in the United States.

4. Impact of domestic and foreign competition has cost coal millions of tons of production, reduced coal-mining jobs by tens of thousands, and cost the economy of the country many millions of dollars annually.

5. Reduction of coal production, by 231 million tons (from the peak year of 1947), has seriously affected the welfare of the almost two million Americans who depend directly upon the industry for a livelihood.

6. USSR outproduced the U.S. by 125 million tons in 1958.

Another Power Tool . . . .

Operate Your Valves the Easy Way

Operation of large, high-pressure valves had always been an unpleasant chore in steam plants, until a new power tool was developed. Here is how it works

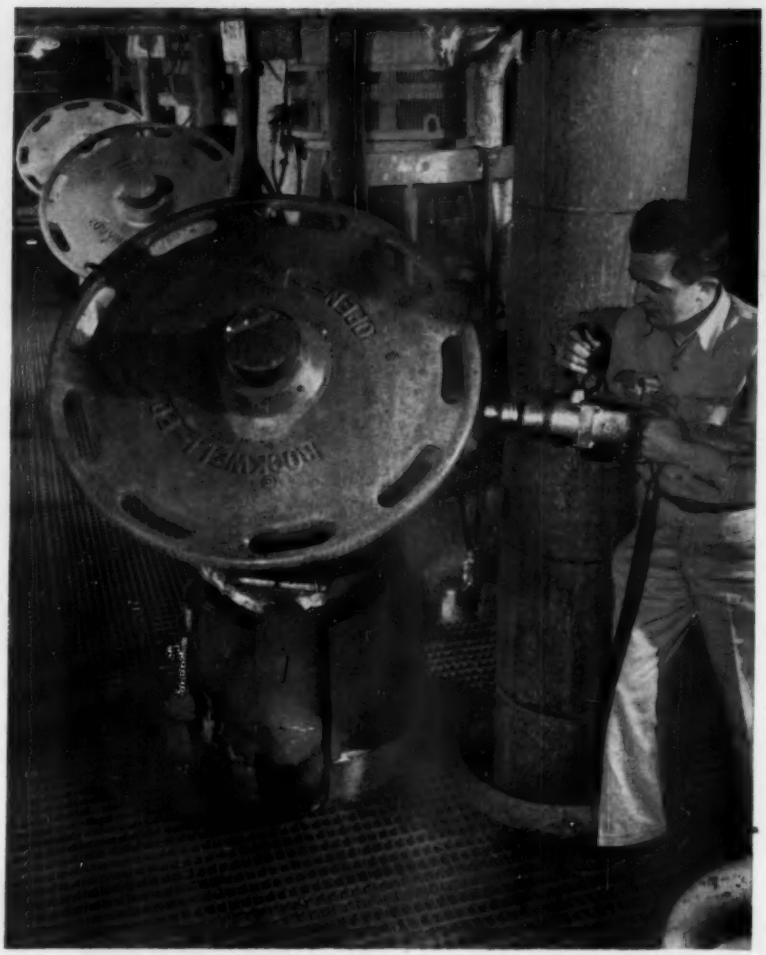
A PORTABLE-POWERED, air-actuated valve operator cuts valve operating time from 15 minutes to 1 minute on three 10-in. stop-check angle valves at a large Midwestern utility. The valves are equipped with the Impactogear air-powered operator, made by Edward Valves, Inc, a subsidiary of Rockwell Manufacturing Company. Impactogear is a pinion-and-ring-gear mechanism driven by a portable air motor to move the valve stem between open and close. Final seating is accomplished with the conventional Impactor hand wheel.

Operated from station 90-psi air by a standard portable air wrench, the three valves are served by one plug-in air outlet. The Impactogear-equipped valves are in the feedwater circuit of a controlled circulation boiler, rated 840,000 lb per hr at 1600 psi and 613 F.

A minimum of 15 minutes had been required to run a valve stem from seat to backseat when the valves were manually operated. At least two men were required. In the summer, when the ambient temperature rises and the valve handle is too hot to be turned with bare hands, four men were required. Two would work while the other two rested. The two-man teams would switch on and off every few minutes. As much as 30 minutes would elapse before the stem had completed its travel.

Typifying the industry-wide trend to fewer operating personnel per unit, this power plant uses only three operators per unit (boiler, turbine, and auxiliary), plus an ash-handler and a helper who usually work more than two units. Additional time was required to round up the two- or four-man crews among the helpers, ash handlers, and auxiliaries operators.

This portable-powered, air-actuated tool cut operating time from 15 minutes to 1 minute and eliminated the time delay for rounding up manual labor in a station where operating personnel are at a minimum. Quicker operation and longer packing life result.



Large steam valve being operated by one man, with air tool. This job normally requires two men, and about 15 minutes—to completely open, or close, the valve

Each valve is exercised once every two weeks. Two of the three circulating pumps, each rated 4700 gpm, can carry the boiler if required, but all three are normally operated continuously.

The 90-psi compressed air system provides ample power to operate the valves through the portable, small air wrench. Feedwater piping layout can be more compact, since no clearance room is needed for the several men usually needed to operate a large valve manually.

While this Midwestern utility has applied Impactogear to 10-in. valves initially, Impactogear can be fitted to any 10-, 12-, 14-, or 16-in. Edward valve, rated 900 psi or higher. Industry-standard air wrenches are readily available to match the requirements of Impactogear. Typical applications of standard air wrenches can be illustrated by two cases:

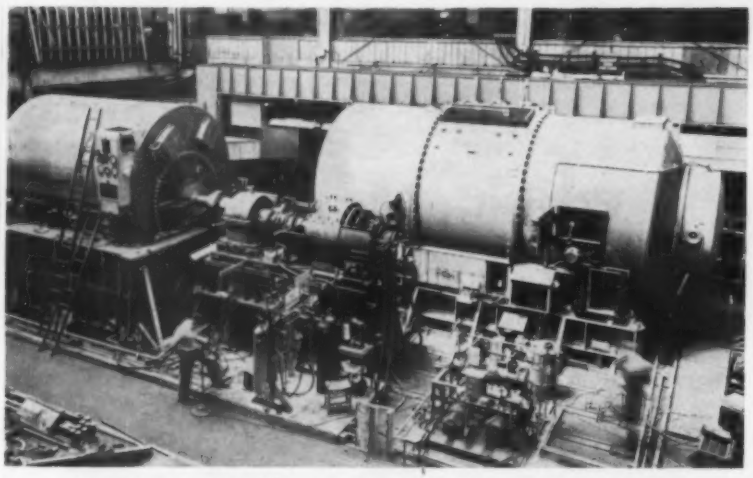
Case 1, Wrench "A" (rated stall torque, 170 ft-lb; free speed, 225 rpm; weight, 12 lb); can be used to close on all operating pressures allowable for 900-psi valves (120 and 14-in.), 1500-psi valves (10-, 12-, and 14-in. valves); and to 3500-psi on 2500-psi valves (12- and 14-in.).

Case 2, Wrench "B" (rated stall torque, 200 ft-lb; free speed, 300 rpm; weight, 38 lb); can be used to close against operating pressures from 3500 to 4500 psi on 2500-psi valves 12- and 14-in.). THE END

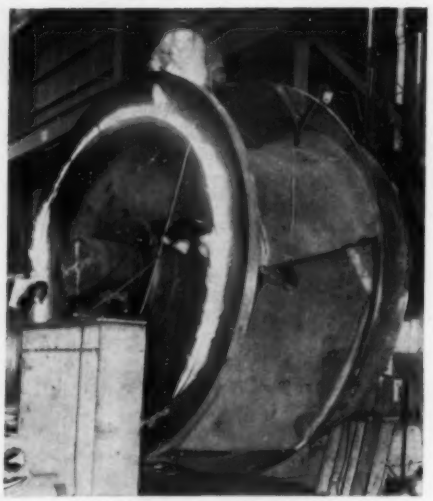
POWER ENGINEERING'S

X-ray inspection is given joint weld on a length of 18-in. diam steel piping at Blaw-Knox's Pittsburgh plant. This pipe will be used in a hot reheat line for a utility company steam generating station

New 335,000-kw generating unit of Con Edison at Arthur Kill in Travis, Staten Island. This new unit raises the system's total generating capacity to 4,426,000 kw. Turbine generator, made by GE, is a hydrogen-cooled, cross compound, close coupled, double flow machine. Steam enters the turbine at 2000 psi, 1050 F, is reheated to 1000

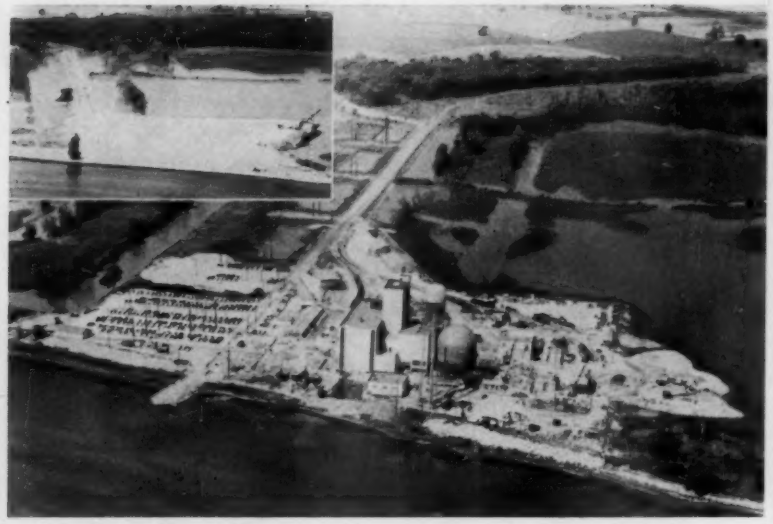


Simultaneous testing is being given these two large synchronous machines at Elliott Co's plant. At right is 50/60-mva hydrogen-cooled condenser built for Montana Power Co. Adjoining is turbine generator with capability of 44,117 kva, 30 psig hydrogen pressure

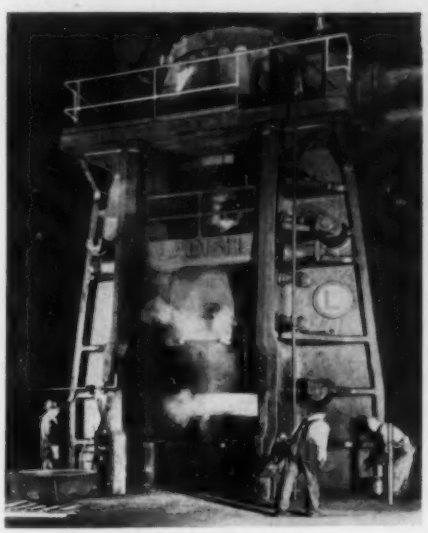


Circle of flame around impeller runner results from pre-heating process, continued until welding of vanes is completed. This reduces moisture and guards against cracking. Unit is for Allis-Chalmers pump-turbine

NEWS REEL



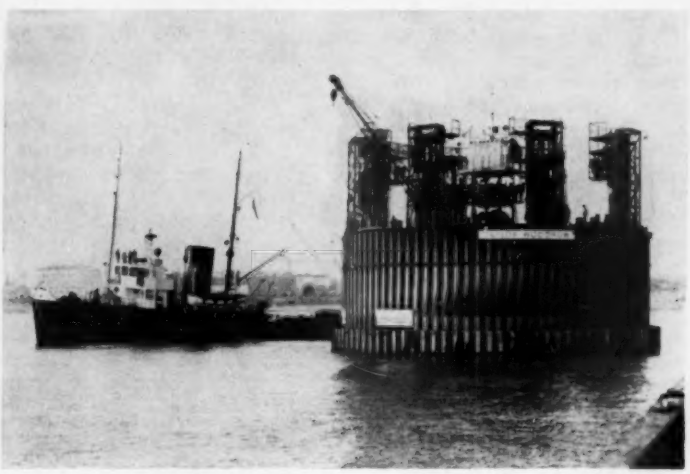
Progress at Enrico Fermi Atomic Power Plant on Lake Erie near Monroe, Mich, is shown in this 3rd anniversary view, as contrasted with site as it appeared on August 8, 1956. Completion date for the entire plant has been set by Detroit Edison as August 31, 1960



World's largest drop forging hammer is said to be this Ladish counterblow hammer with 96-in. vertical stroke between twin rams, which exert a force of over 100,000 tons at moment of impact, releasing 1,500,000 hp

Air pollution control experts examine operating scale models of electrostatic precipitators at recent meeting in Los Angeles of Air Pollution Control Assn. Models by Western Precipitation Corp

Half a "spider" under construction at Westinghouse. This 25-ton piece will be joined with its matching half for installation in a 167,000-kva waterwheel generator being made for New York's Niagara Power Project



Atomic island sets sail. A man-made 3900-long-tons concrete island is being anchored on steel legs built into the bed of Bristol Channel, England. It will pipe sea water under the sea bed to Hinkley Point Atomic Power Station for cooling of two reactors. Here the island starts on its first and last voyage, of 2000 ft

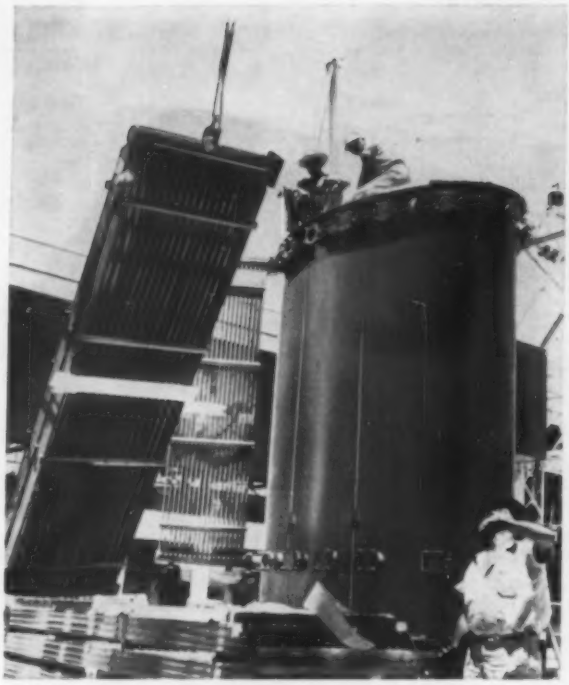


Fig. 1. Radiators detached for shipment should be installed first. Transformers should always be handled in their upright position unless they are made for non-standard lifting

Fig. 2. Oil-filled bushing is installed with aid of rope sling. Bushings should be removed from their excelsior packing as soon as possible and placed on a rack in an upright position

Tips on Transformers

This guide to better transformer performance starts with helpful directions on how to receive your transformer and prepare it for service. Later articles will focus on operation and maintenance

By A. J. BECKER*

ARRANGEMENTS should be made in advance for adequate and safe handling of the transformer. This ordinarily includes such equipment as railroad crane, mobile crane, car wheels and rails, rollers, skids and cribbing. A reliable rigging company can furnish this complete service.

Greater care is required when handling ventilated dry-type transformers because they are housed in a lighter gage case. During inclement weather, they should be thoroughly protected against moisture.

Check material. Separately packed material should always be opened and checked against packing list. Anything for storage should be properly wrapped and kept in warm, dry area.

Oil-filled bushings should be removed from excelsior packing and placed as soon as possible on a rack in an upright position. For bushings with shanks other than porcelain, keep in dry atmosphere.

All transformers are carefully inspected when shipped. However, occasionally damage may occur en route.

External check. Remove protective covering from bushings and accessories and examine for breakage or leaks. Transformer gages should be checked for any abnormal readings. Look over radiators, base, tank surface condition, relief device and its diaphragm. Remove shipping material, such as cork fillers, hood springs, plugs or caps and any blocking units. Temporary metal shipping parts are usually painted bright yellow. All tags, instruction booklets or forms should be studied and filed with other job records.

Internal check. Transformers should be opened only in fair weather or when properly protected.

Tank pressure should be relieved by bleeding a valve or plug above oil level or by other approved means. Only then should handhole covers or blank flanges be removed from tank.

Nitrogen in tank should be driven out and replaced with fresh air before working inside tank. Safety precautions include a watchman when it is necessary for a man to be inside the transformer.

Men working on an open transformer should remove all loose articles from their clothing. Use as few tools as necessary. These must be in perfect condition and tied securely. Take inventory of tools so none are left inside the transformer.

Internal inspection includes following:

1. Look for moisture condensation on underside of cover, on terminal board or lead supports.
2. Measure dielectric strength of oil.
3. Examine cable insulation, brazed studs or connections.

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* Service Engineer, Allis-Chalmers, Pittsburgh Works

Fig. 3. Railway crane simplifies unloading of this 15,000-kva, 60-cycle, 3-phase transformer. Always use the tank lifting hooks, jacking pads, lugs and braces that are provided

Fig. 4. When a transformer cannot be moved by crane, it may be skidded on channels or moved on rollers. Skids between rollers and base equalize stress, prevent side slipping

4. Check operation of tap changer, its mechanical strength and contact.

5. Nuts and bolts should be checked for tightness.

6. If possible, examine bottom of tank and all horizontal surfaces for loose parts or materials.

Storage

When a transformer is not to be energized for an appreciable length of time, certain precautions are necessary to keep it in serviceable condition.

Breather-type transformers should have breathers connected to dehydrating equipment (contains activated alumina or silica gel); or, transformers should be stored in a dry, heated area.

Oil-sealed inert gas system transformers should have gas space purged with nitrogen until oxygen content is less than two per cent if transformer is to be de-energized for periods longer than three months.

Positive-pressure inert gas system transformers should be purged to an oxygen content of less than two per cent, and periodically tested for gas supply.

Sealed-type oil-insulated transformers should be thoroughly inspected and tested for leaks before storing.

Core and coil assembly sealed in dry nitrogen should be covered with transformer oil if possible. If not, then the case should be purged with dry nitrogen to an oxygen content of less than two per cent and sealed. Keep internal pressure slightly above atmospheric pressure to prevent breathing. Check pressure and oxygen content periodically.

Disassembled oil-insulated type of transformer should be immersed in dry transformer oil and stored in dry room with uniform temperature.

Askarel liquid-filled transformers are always stored, filled with the liquid and properly sealed. Check both the liquid level and its dielectric strength occasionally. Clean and dry all transformer parts if not stored under liquid along with transformer.

Ventilated dry-type transformers are always kept in a dry, heated area. If such area is not available, then the transformer should be covered to keep out dust, foreign material and moisture. Space heaters should be used to keep temperature of transformer above ambient temperature.

Sealed dry-type transformers should have tank seal tested and then maintain gas pressure during storage period.

Today's transformers in the medium power range are, for the most part, ready for immediate installation. Bushings have been installed and radiators have been welded in place.

Large transformers, because of height and weight restrictions, usually require some assembly work at the installation site. Ordinarily, bushings and radiators are detached and their normal location covered by a shipping plate (usually a conspicuous color). Remove these plates only after transformer is placed on the foundation pad.

Preparing for Service

Here's the proper procedure for installing radiators:

1. Close top and bottom radiator valves before removing shipping plate over tank flanges.

2. Remove shipping plate from radiators.

Why This Article

Although transformers require less care and attention than most other types of electrical apparatus, their continued operation and long life will be determined by the manner in which they are installed, operated and maintained. This article is the first of three which will give a better understanding of the equipment and how to handle it.

Table I. Things to consider in selecting transformer site

	Outdoor	Indoor
Codes and Regulations	Local, state, and national codes and regulations specify safety requirements which must be met.	
	Fenced enclosure required for most installations.	Oil-filled transformers require fireproof vault. Askarel-filled and dry-type transformers generally do not require vaults.
Accessibility	Site selected should be readily accessible to personnel for inspection and maintenance. Space should be provided to check accessories and gages properly. Gages overlooked inadvertently during routine inspection could prove costly.	
Ventilation	Usually no problem.	Room should be well ventilated and dry. Instructions with each transformer ordinarily specify the amount of cooling air required. At least 24 to 36 in. should be between units or units and wall. For ventilated dry types, air should be clean and dry so insulation and tap changers, etc, serve guaranteed life.

Table II. More factors that have bearing on transformer site

	Outdoor	Indoor
Noise	Objectional noise can be lowered by landscaping with suitable shrubs and trees. Decorative baffles may also be used, but do not block air circulation.	Transformer room should be walled with acoustic absorption material. Unit should be mounted on resilient pads.
Drainage	Unit should be located in a curbed area which is filled with crushed stone with sufficient depth to absorb or drain contents of transformer.	Drains should be provided to handle fire protection system discharge, and transformer coolant. See National Electric Code and Factory Insurance Association regulations.
Proximity to power generation and load	Transformers should be located as near as possible to the generator if they are to be used for step-up service, or to the load if they are used for step-down service. This keeps length of the heavy current carrying leads to a minimum, results in the best performance.	

3. Inspect headers of radiators for moisture, dirt, or contaminated oil. If evidence is found, wipe them clean and install them on transformer tank — then remove pipe plugs from top and bottom of headers. Connect to a drum of transformer oil and filter press. Flush until clean. Discard oil if it cannot be filtered clean. Re-install pipe plugs with a good quality oil-proof thread compound.

4. Thoroughly clean gasket seats and install gaskets.

5. Use lifting eyes to hoist radiators into position. Bolt firmly to tank wall or radiator valve flange.

6. Vent transformer tank. Open bottom valve, followed by top valve, for each radiator.

Oil in the main tank gradually levels off as the radiators fill, making it more convenient for the next step.

Installing Bushings

1. Inspect all bushings. Replace or repair as required.

2. Clean thoroughly with an oil-free cleaner (clean inner tube also if draw-lead type of bushing).

3. For bushings 69 kv and smaller, hoist with rope under top petticoat of bushing.

4. For bushings above 69 kv, hoist by lifting eyes in mounting flange. Attach block and tackle to terminal cap eye for pulling bushing to vertical position. Caution: large bushings (above 161 kv) should not be handled by the cap eye.

5. Remove bushing-port shipping covers. Disconnect draw leads and pull leads through cover.

6. Clean flange. If port flange is recessed, insert gasket. If not, then apply gasket to bushing flange.

7. Insert chain snake through center tube of bushing. Place bushing above bushing port. Attach draw lead to snake and pull lead through bushing as it is carefully lowered into the port (avoid contact with bushing-type current transformers, if furnished). When terminal stud projects sufficiently, insert locking pin. Carefully tighten flange bolts and install terminal gasket and cap.

8. If bushings are the fixed-conductor type, they must be connected internally after the external work is completed. Oil in transformer should be drained into clean drums for sufficient work clearance. Tie a guard cord to all tools to prevent possible accidents.

9. Adjust terminal gaps (if supplied) to proper setting.

Before sealing handhole covers or filling transformer to proper level, an internal inspection should be carefully made as follows:

Check These Points Before Applying Voltage to Transformer

1. Be sure internal inspection has been completed.
2. Check all alarm circuits.
3. Clean bushing porcelain with carbon tetrachloride and make certain bushing oil is at proper level.
4. Have transformer oil at proper level in all compartments. Oil should settle for 12 hours if transformer is not vacuum filled and should test 26 kv or higher.
5. Check seal at all openings and joints.
6. Oil preservation and expansion system should be in operation.
7. Remove all objects from atop the transformer.
8. Have all winding neutrals so designed properly grounded.
9. Set tap changer for de-energized operation on proper tap position.
10. Make certain there are no open circuits in current transformer secondaries.
11. Check all alarm circuits.
12. Make insulation test on all control circuits.
13. Check cooling system for proper operation if transformer is artificially cooled.
14. Check ratio on full winding position and on each tap position. Apply available voltage on high-voltage winding.

Make certain all temporary internal bracing used for shipment has been removed, and all terminal board bolts have been checked for tightness.

Check tap changer alignment and contact pressure of fingers on all tap positions.

Be sure windings and insulation are dry. Check cable insulation, brazed studs or connections.

Internal Inspection

Check to make sure all radiator valves are open.

Then, secure all handhole covers and inspect relief diaphragm for serviceability. Test protective hood.

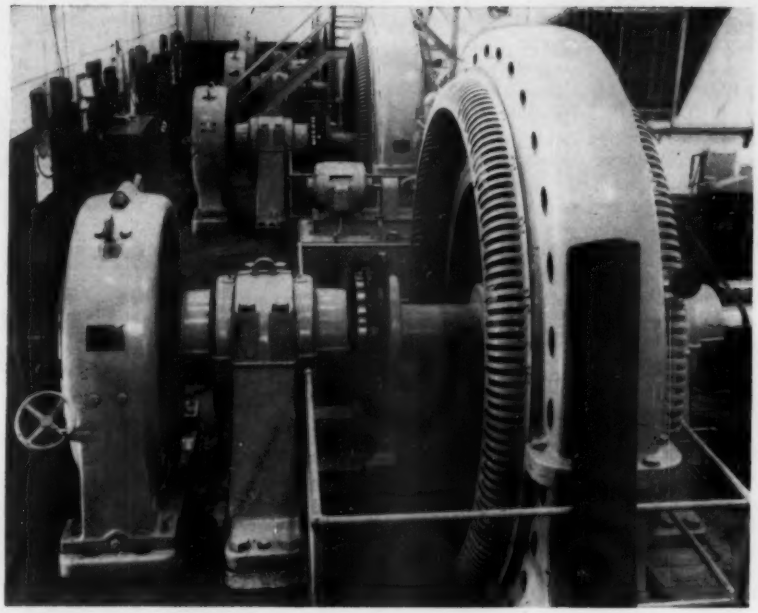
Open the tank vent on the cover, and through a filter press bring the liquid to its proper level. Reseal vent.

If transformer is equipped with a gas-oil seal or positive-pressure system, purge it with dry nitrogen until oxygen content is below two per cent. Check all gasketed joints for leaks.

Important: Where oil has been below the core and coil, after filling allow it to stand for about 12 hours before energizing. This time can be reduced considerably if transformer has been filled under vacuum. If oil has been above the assembly, then no waiting period is necessary after the required oil level is reached.

If nameplate does not indicate vacuum filling, always consult manufacturer before applying vacuum to transformer case. Tank may not be designed to withstand vacuum.

Make sure the transformer is permanently and effectively grounded. A poor ground may develop that would be dangerous for anyone working around the transformer. Always follow nameplate for specific grounding instructions regarding winding neutrals. THE END



Nine Mile Power Plant of Washington Water Power Co, showing units that were rewound with silicone material for longer life and greater capacity

When heat generated by electrical overload disintegrated the original insulation, Washington Water Power adopted new rewind methods to get greater capacity and prevent breakdown

Electric Utility Upgrades Generators By Rewinding With Silicones

By **FRANK E. GARRISON***

WASHINGTON Water Power Co is a large electric utility supplying Spokane, Washington, and areas throughout eastern Washington and northern Idaho. They have a number of hydroelectric stations, all operating at full capacity.

Early in 1958, three of their generators failed within a period of one week. Spare set of coils was available for one of these units, but this was not the case with the other two. Loss of this generating capacity was very critical, and speed in getting them back on the line was of utmost importance.

Two units for which spare coils were not immediately available were identical generators rated at 3000 kw, 240 rpm, three-phase, 60 cycle, 2200 v. Each stator contained 360 bar copper coils, connected 4-circuit-Y.

These units were originally installed in the Nine Mile Power Plant of Washington Water Power Co in 1906.

While having operated at some overload for years, heavy demands during and since World War II called for loads far in excess of rated capacity.

One generator failed in 1948, and the other failed in 1949. Both were rewound, using the original coils and insulating them with mica insulation bonded with paper. No temperature detectors were installed in the windings. Both generators continued to operate in excess of rated capacity, using the iron temperature as a basis for generator loading.

In 1958, both units failed again within the same week. Upon examination, it was found that paper used in bonding the mica had completely disintegrated due to excessive heat caused by overload. It was felt that a wound coil would be preferable to the bar copper coils. Shutdown time again was critical, and it was determined once more to reinsulate the original coils.

Construction and maintenance personnel of the Washington Water Power Co met with Hugh B. Tinling, managing partner of Tinling and Powell, to determine feasibility of using newly-developed insulation materials, to overcome insulation damage due to heat and, at the same time, to rate the generators upward. Decision was made to use silicone, glass, and mica insulating materials.

Additional heating elements were added to the ovens to give a baking temperature of 400 F, as required for silicone materials. Oven circulating fans had to be rewound with glass insulating materials to withstand the extreme heat.

Problem of obtaining necessary materials was also acute. Total of 100 gal of Dow-Corning 997 Insulating Varnish was obtained on the Pacific coast in small lots of 1- and 5-gal cans. Silicone mica tape was unavailable locally and had to be brought in by air express.

Despite these various problems, Tinling and Powell were able to complete the entire job of insulating 720 stator coils, 196 jumpers, 24 phase rings, and making 2360 wedges and 650 glass bags for coil connections in approximately three weeks.

Considerable experimentation was necessary to arrive at a final process. Originally, it was planned to use glass tape with silicone varnish. It was found that, due to the coarse mesh, glass tape did not absorb enough silicone varnish and therefore lacked dielectric strength.

After then deciding on the use of isomica, too much insulating material was used through the slot section of the coils. Silicone varnish dips built up the coils more than was anticipated, with the result that several coils had to be reinsulated to obtain

*Vice-President & Gen Mgr, Tinling & Powell, Inc

correct thickness. Process finally used on the stator coils was:

All coils were taped with four layers of half-lap, glass-backed silicone tape, 1 in. by 0.007 in. One layer of ¾-in. by 0.007-in. fiber glass half-lap tape was then placed as a binder over the entire coil, except through the slot section, which was butt-lapped.

Coils were then placed in the oven to pre-bake for four hours at 350 F. Silicone glass-mica tape binder is only partially cured when received; this baking finishes the curing and seals the layers, making it a homogenous mass.

After this initial baking, the following steps were taken:

1. Cool coils to room temperature.
2. Dip in Dow-Corning 997 Silicone Varnish for 10 minutes or until excessive bubbling stops.
3. Air-dry for one to three hours.
4. Bake two to four hours at 350 F.
5. Cool again to room temperature.
6. Dip for one minute in silicone varnish.
7. Air-dry for one hour.
8. Bake for two hours at 350 F.
9. Cool to room temperature.
10. Dip for one minute in silicone varnish.
11. Air-dry for one hour.
12. Bake four hours at 350 to 400 F.
13. Cool to room temperature.
14. Tin coil ends.

After completion, each coil was tested at 7200 volts to ground, by Tinling and Powell. Washington Water Power, in turn, tested the coils with high-potential direct current at 9000 volts, with a resultant leakage to ground of less than one microampere.

Wedges for the stator, totaling 2360, were made of silicone glass laminate. A total of 650 glass cloth bags for coil and connections were made, using two thicknesses of 0.030-in. glass fiber cloth, impregnated with baked silicone varnish. Total of 18-10-ohm, 25-C resistance-type temperature detector coils were purchased and installed in the stators.

Each generator was out of service for approximately five weeks due to the breakdown. Considering scope and size of the job, employees of both companies are to be commended for returning the units to service in this very excellent time span.

Both these generators have now been back in service for more than a year. They have been, and are being, operated at 4000 to 4400 kw. These are loadings of from 33 to 45 per cent above the original rated capacity.

Temperatures periodically are taken. Stator temperatures vary from 126 C to 158 C (259 F to 300 F). Iron temperatures vary from 78 C to 105 C (173 F to 221 F). There has been no indication whatsoever of insulation breakdown. THE END

New Diesel-Crankcase Explosion Relief Valve

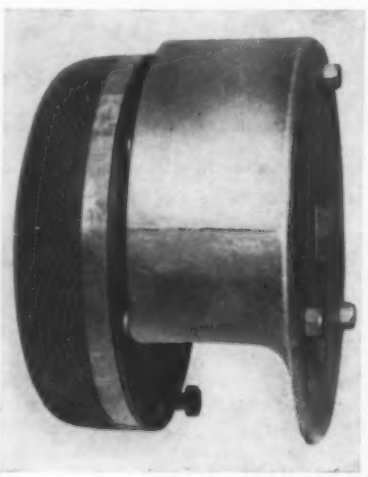
TO AVOID a dangerous pressure-rise and resultant damage in the event of an explosion occurring in the crankcase of the larger types of compression ignition engines, it is necessary to provide pressure-relief valves of ample area. However, unless such valves are provided with effective flame traps, they may actually increase the danger to personnel, since explosions too weak to damage an unrelieved crankcase can produce a large emission of flame through unprotected relief valves.

A most satisfactory type of flame trap is the internal oil-wetted wire-gauze flame trap, devised and patented by the British Internal Combustion Engine Research Association after a thorough investigation of the problem. In this design the flame trap is placed within the crankcase.

In other designs in which the wire-gauzes are placed on the outside of the relief valve, the flame is concentrated on a part of the gauze areas as a result of the directing effect of the valve aperture, with subsequent destructive effect on the gauze flame trap. The internal arrangement of flame trap can absorb about three times as much heat before allowing the passage of flame, by virtue of the much more even distribution of the flow of hot gases through the gauzes.

It has further been demonstrated that the capacity of the gauzes is roughly doubled by coating them with lubricating oil, as can be done by arranging the gauze assemblies in the path of the sprays from the large-end bearings of the connecting rods, or by supplying oil to them in any other way. The combination of the two improvements makes the internal oil-wetted flame trap about six times as effective as an external gauze flame trap.

It cannot be too strongly emphasized that the degree of protection provided by such valves and flame traps in a crankcase of given size depends on the number and size of units and their relative location.



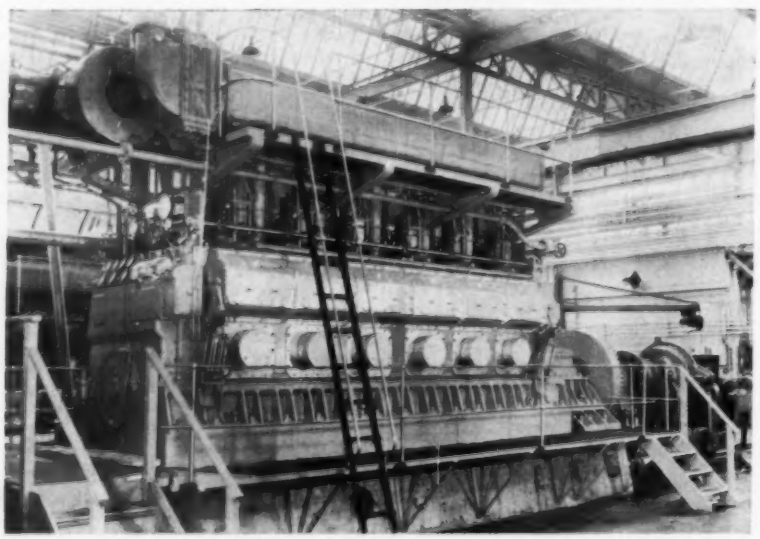


Fig. 1. (Above) Close-up of the valve
Fig. 2. Typical installation on diesel

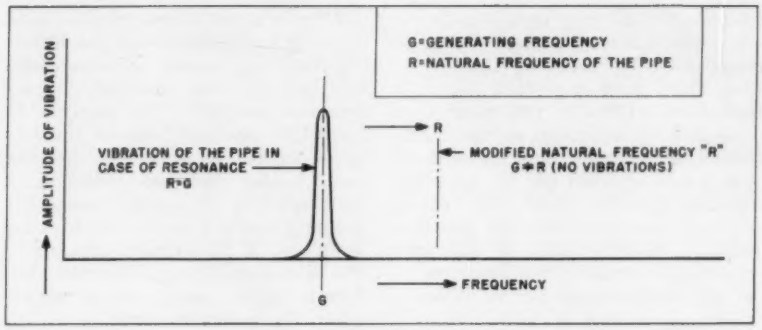


Fig. 1. Illustrating the simple case where vibration is caused from an external source such as rotating machinery. Cure here is easily accomplished

Does Cavitation Cause Feedwater System Vibration?

Persistent vibrations, extremely difficult to diagnose, are becoming more frequent in modern power plants, as systems become more complex. Relationship of the several possible causes to resonant frequency is discussed here, and specific remedies are described

By **ANDRE KOVATS** *

VIBRATION OF steam power plant feedwater piping is always a source of annoyance and may be destructive unless the true cause of the vibration can be analyzed and eliminated.

Obviously it is best to eliminate these causes when the plant is being designed, but this becomes increasingly complex as power plants become larger, with attendant increases in length of piping, higher pressures from boiler feed and condensate pumps, and more feedwater heaters and tanks included in the entire system.

There are two kinds of vibration which may occur as a result of resonance — one, a function of mechanical characteristics of the piping system, and the other induced by internal hydraulic pulsations.

The first, or mechanically-induced vibration, will occur when a freely-hanging pipe has a natural frequency of vibration which corresponds to the speed of some rotating machinery in such a position that impulses may be transmitted to the affected pipe by interconnecting structural members.

Normally, this source of vibration is reasonably easy to diagnose although it may occasionally be complicated by the appearance of harmonic frequencies, which confuse the clear recognition of the source, and by the apparent absence of an interconnecting transmitter. At any rate, vibration in this category is easy to eliminate by "tuning it out." Since the vibrating element, or resonator, has a constant and determinable frequency (R), its natural frequency may be altered by stiffening, as in Fig. 1, or changing the length of the affected section.

Internal Pulsations

Second possible source of resonance, due to internal hydraulic-pressure pulsations, has a pump as the exciting element. The resonator is the entire piping system in which the elasticity of the water, the pipe and any vapor pockets in the piping, heaters, or other auxiliary equipment are the elastic elements.

It is generally assumed that centrifugal pumps have an absolutely steady flow, completely free of the pulsations which are well recognized in reciprocating pumps. Actually this is not entirely correct since the impeller blades moving past the diffusor vanes, or the tongue of the volute, always create a continuing series of pulsations of a constant magnitude.

These pulsations are of such a small intensity that they would not induce vibrations in a normal piping installation although it is possible that they might be amplified by any axial vibration of the rotating ele-

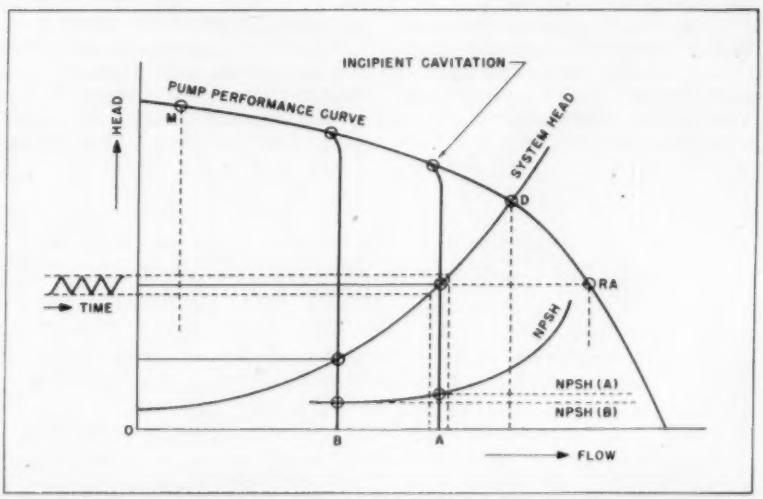


Fig. 2. Characteristic performance curves for a condensate pump illustrate the relationships between the operation of the pump and the conditions of cavitation

* Foster Wheeler Corp

ment, such as may occasionally be experienced in some boiler feed pumps equipped with balancing discs.

A much more important source of pulsation originates with cavitation —usually in condensate pumps. Cavitation is generally considered from the point of view of the expected damage to pump parts. This typical damage does occur when a pump is working at the point of incipient cavitation, close to the break point of the performance curve. When a pump is working in full cavitation, the vapor fills a considerable part of the space between the impeller blades and supplies a cushioning effect which reduces damage to a negligible amount. However, it is evident that the flow and discharge pressure are no longer steady.

Some years ago it was accepted practice to operate condensate pumps with submergence control since this requires no auxiliary control equipment. When submergence control is used, the pump delivers the full capacity in accordance with its characteristic until the level in the hotwell of the condenser, and therefore the net positive suction head, drops below the limit that will prevent flashing in the suction eye of the first stage impeller.

How It Works

When flashing starts, the flow of water is reduced which, in turn, reduces the system head and tends to increase the flow again. Therefore, the pump passes through the point of incipient cavitation and into full cavitation, as shown by the vertical breakdown line "A" of the characteristic performance curve in Fig. 2. The flow would then be established in equilibrium until there is some other disturbing influence.

If the amount of steam being condensed should be further reduced, there would be a further reduction in NPSH (net positive suction head) and another equilibrium operation established at some other flow "B".

When a pump is operating in cavitation at some equilibrium condition, the flow may appear to be steady, but actually this can only be an apparent average. The collapse of the vapor pockets between the impeller blades is periodical, and as each pocket collapses, there is a corresponding reduction in occupied volume, resulting in an instantaneous reduction in velocity and pressure in the discharge piping. Therefore, the flow is never steady, and an apparently steady flow at capacity "A" in Fig. 2 is actually oscillating between the dotted lines as shown.

Variations in Frequency

Frequency of this pulsation is not constant, even for an equilibrium condition, because the dimensions of the vapor pockets do not have precise geometric similarity. When there are two or more pumps operating in parallel, each will have a slightly different mean frequency, and the combination may give an even more variable resultant which will be different for all combinations of flow and temperature. It will be appreciated that this is a pulsation generator without a measurable or calculable frequency. It can only be said that it has a wide range which may be taken as "G" on Fig. 3.

Consider now this resonator composed of pipe, heaters, tanks, water, and vapor pockets trapped within this system. Certainly, steel has an important elasticity, and pipe bends will tend to act like the Bourdon tube in a pressure gauge. In most modern plants the elasticity of the water is a finite value, but the entrapped vapor pockets may have the most significant reaction. They act like springs, but the "spring constant" depends on the size, pressure and temperature of each pocket.

Frequency of pressure swings must depend on the water velocity, the length of the piping system, and the character of the water and vapor pockets in the system. The natural frequency may be calculated by using the formulae of Alievi and Bergeron. The longer the pipe the more extensive the vapor pockets for a given flow velocity and the lower will be the natural frequency. But in this case the resonator system also has a variable natural frequency, as indicated by "R" on Fig. 3.

Conditions Causing Trouble

When zones "G" and "R" are far apart there is no trouble. The typical frequency of pulsations of one condensate pump running in cavitation would be between 500 and 5000 cycles per minute. The natural frequency of a relatively short piping system including one or two heaters would be much higher — probably between 10,000 and 20,000 cycles per minute. This combination would not have much possibility of vibrating and is typical of the relatively old plants where submergence control was used for years and never gave any trouble.

Two pumps working in parallel would be much more likely to give trouble. If, as is the case in many new power plants, the pump, or pumps, may be of the vertical-pit type, the volume of the suction tank may appreciably reduce the natural frequency of the system and be more likely to result in vibration.

With a long and complex piping system, including several feedwater heaters, and particularly with a deaerating heater, the natural frequency, "R", may be so low that at some flow the zones "G" and "R" coincide. Under this condition, the usually insignificant pulsations may be multiplied in intensity to pressure peaks appreciably higher than the steady-flow discharge pressure. The pressure peaks are not liable to be dangerous in themselves, but the vibration which they create can be serious.

It is possible to make changes in the natural frequency of the piping system by adding surge tanks or

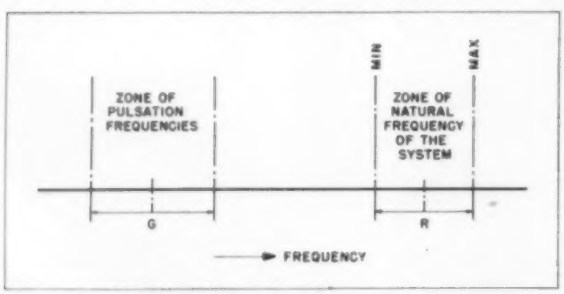
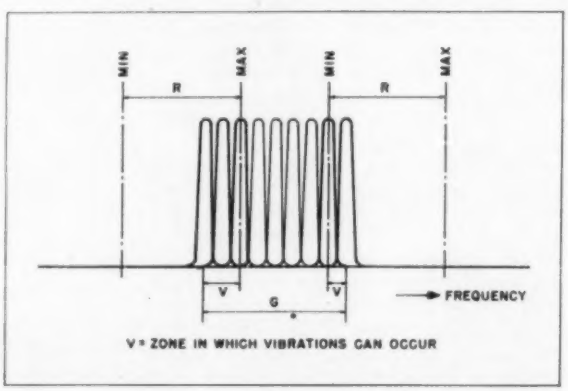


Fig. 3. (Above) Graph of conditions which are necessary in order to prevent vibrations caused by hydraulic pulsations Fig. 4. (Right) This graph illustrates the frequencies where vibration may occur due to coincidence of zones "G" and "R"



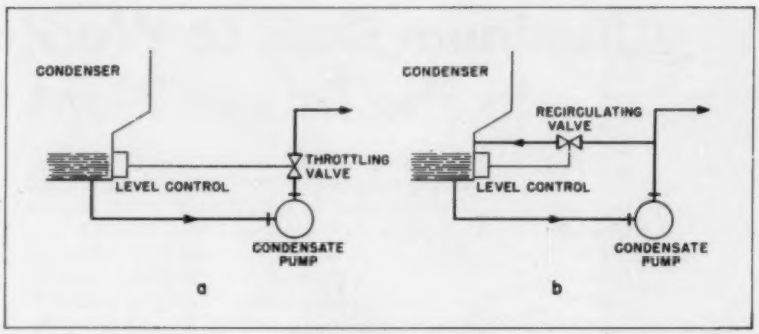


Fig. 5. Two methods of control effective in avoiding the danger zones shown in the curves in Fig. 2. Either will be effective in avoiding operation at flow "A"

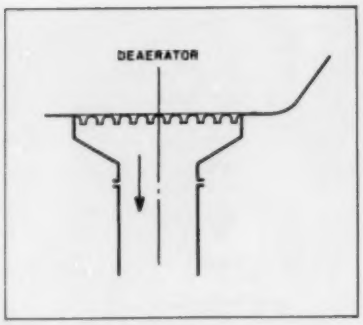


Fig. 6. Vibrations may sometimes be decreased by flared nozzles of this type

altering the sizing of some of the pipe. This is rarely completely effective since the value of "R" may be changed only enough to be critical at some other flow. Also, additional anchors and stiffening of bends may stop the vibration, but this only suppresses the immediately apparent consequences of the pressure pulsations.

Obviously the only sure way of eliminating the tendency to vibrate is to eliminate the uncontrolled flow variations shown at "A" in Fig. 2. This means that submergence control must be discarded in favor of throttle or recirculation control.

In the case of throttle control, Fig. 5a, an automatic float-operated valve, controlled by the level in the hot well, is used to adjust the flow. The pump is working along the performance curve between the points of design flow "D" and minimum flow "M" on Fig. 2. A small recirculating valve is also needed in this system to assure the required minimum flow. This valve must be opened when the flow is reduced to less than "M".

In the recirculation control system, Fig. 5b, the automatic float-operated valve opens when the level in the hot well of the condenser drops and the excess capacity of the pump is discharged back into the condenser. If the steam consumption corresponds to flow "A" in Fig. 2, the pump will operate at point "RA" of the performance curve. The capacity difference "A-RA" is recirculated. Evidently at higher capacities than the design flow the pump needs more NPSH — otherwise it operates in cavitation.

Boiler Feed Pumps

In boiler-feed-pump service there should not be a similar problem if the NPSH has been correctly calculated, although an adequate margin above the minimum NPSH must be maintained to prevent cavitation during rapid load changes. Such temporary cavitation would also create pulsations which could induce serious vibration at certain critical flows.

It is also possible to trace the source of vibration to the boiler feed pump when the normal pulsations, amplified by axial vibration of the rotating element, happen to be in tune with the natural frequency of the piping system. This is more likely to be found when there is a deaerating heater in the system.

For example, in one case the axial vibration of the rotating part of a boiler feed pump could not be eliminated by any change of the balancing device. Since the vibration began at about half of the full capacity, increased with the flow, and coincided also with the vibration of the suction pipe line, it seemed possible that the source of vibration was outside the pump.

Frequency measurements indicated no relation to the speed of the pump. Opening the valve of a bypass line changed the frequency. Eventually, flared nozzles were installed in the outlet of the deaerator, as in Fig. 6, to damp the pulsations. This modification eliminated the vibrations.

Vertical Condensate Pumps

Sometimes it is difficult to distinguish between a mechanical and a hydraulic source of vibration without using proper instruments. Pump casings and motors of vertical condensate pumps are especially inclined to vibration. Unbalance of rotating parts and resonance with the speed of the motor can be easily detected since the frequency of the vibration corresponds to the speed of the motor and is independent of the flow.

But if the pump casing with the motor on top has a natural frequency only slightly different from the frequency of the motor or an outside source, as vibration of the base of the generator unit, a beat can result that may be mistaken for vibration resulting from pressure pulsations.

True Analysis Needed

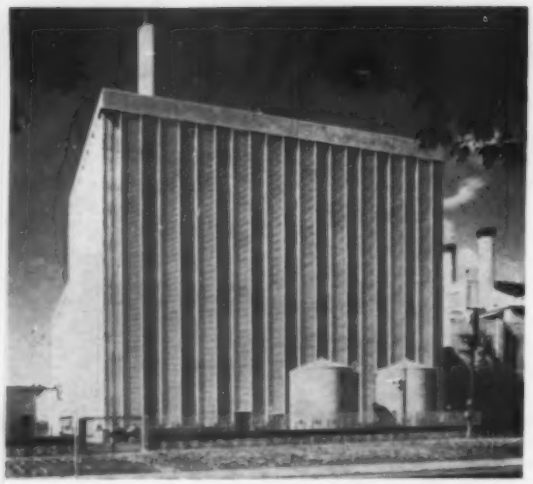
The variation of the flow is linked with load variation and therefore with a slight variation of the speed of the motor. That is enough to change considerably the frequency of the beat and gives the impression that the vibration frequency varies with the flow. In such cases only by recording the vibrations and analyzing the curves can the true source of vibration be found.

In conclusion, it must be recognized that previous successful operation cannot always be accepted as the criterion for future design. Large modern power plants, with two or more condensate pumps in parallel operation in much more complex piping systems, are more susceptible to piping vibration.

Furthermore, even two presumably duplicate units will not have precisely the same characteristics. It is evident that it is always preferable to eliminate the cause and, therefore, the effect. THE END

Transmission Line Reprints Now Available

Electric Transmission Lines: How to Design and Build Them is the complete story of how a typical electric transmission line is conceived, designed, and constructed. This three-part article, which recently appeared in POWER ENGINEERING, has been reprinted and is ready for the power engineer who needs a good guide to all phases of electric line construction. E. P. Naney of Interstate Power Co, the author of this important work, is a power engineer who has spent many years in this field. Write for your free copy or ask for quantity lot prices by addressing the Editor, POWER ENGINEERING, 308 E. James St, Barrington, Ill.



Louvers in Hawaiian Electric Co plant give ample ventilation as well as protection from heavy rains, also lend architectural distinction

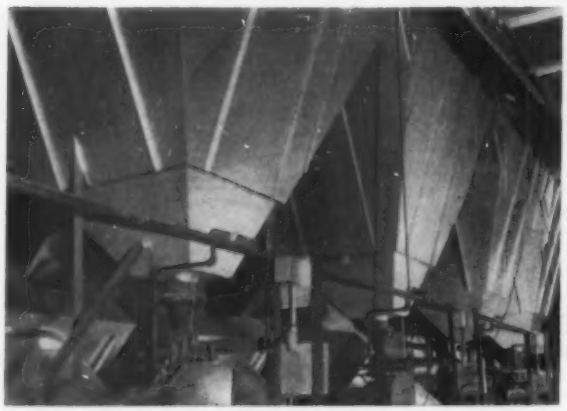
Aluminum Goes to Work In the Power Plant

USE OF ALUMINUM in the electrical power field has been largely concentrated in transmission conductor and bus applications. More recently, development work has led to aluminum applications for building siding, covered conductor, conduit, substation structures, insulation jacketing, boiler lagging, and instrument tubing, at a competitive cost.

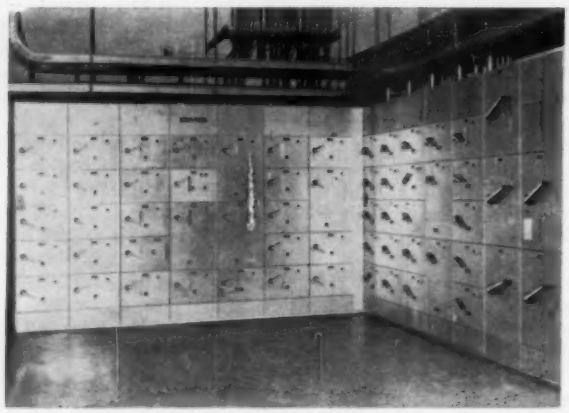
In addition, a number of applications are testing aluminum for stacks, cabinets, piping, ducts, roofing, condenser tubing, fencing, transmission towers, cooling towers, condensate tanks.

Trend to aluminum has been sparked largely by the increased labor and materials costs for servicing utility equipment. More than ever, designers must consider maintenance as a formidable factor in total operating costs. Although use of aluminum may mean higher first costs, when operating and maintenance costs are weighed in proper context, this premium will often evaporate within a relatively short time.

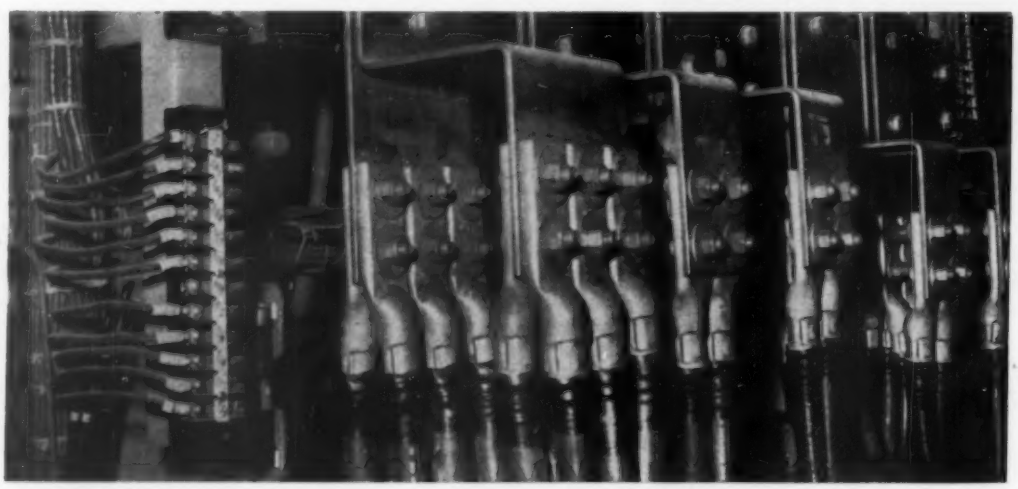
Photos courtesy of Kaiser Aluminum & Chemical Sales, Inc



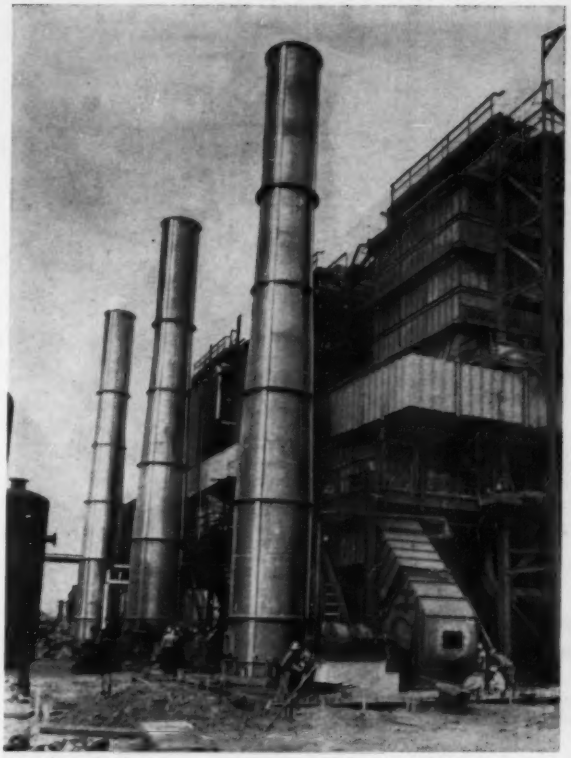
Aluminum for boiler lagging, gas equipment, breeching and dust collector casings is a trend. These convection pass hoppers use it, in Ohio Power Co's Muskingum plant



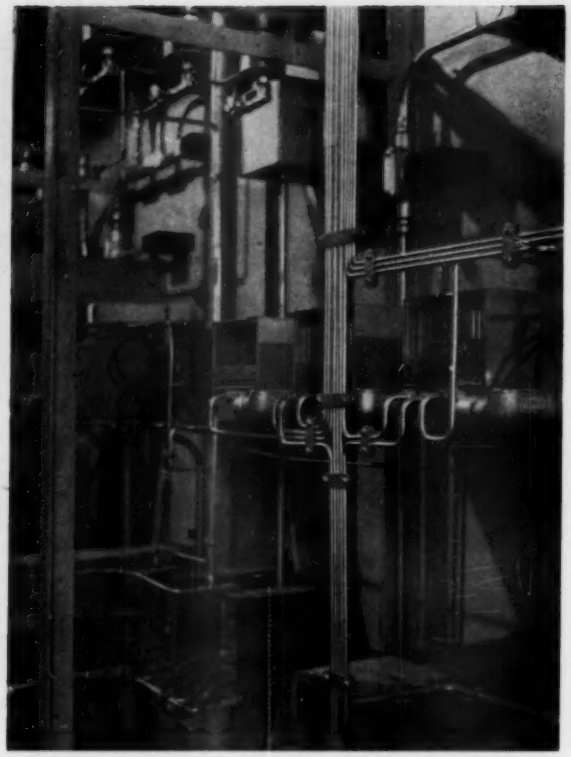
Switchgear, aluminum clad, is shown here at Kaiser Aluminum & Chemical Corp's reduction works at Chalmette, La. Several companies now offer aluminum-clad switch gear



Insulated aluminum conductor is a recent cost-saving development. Terminations have aluminum lugs

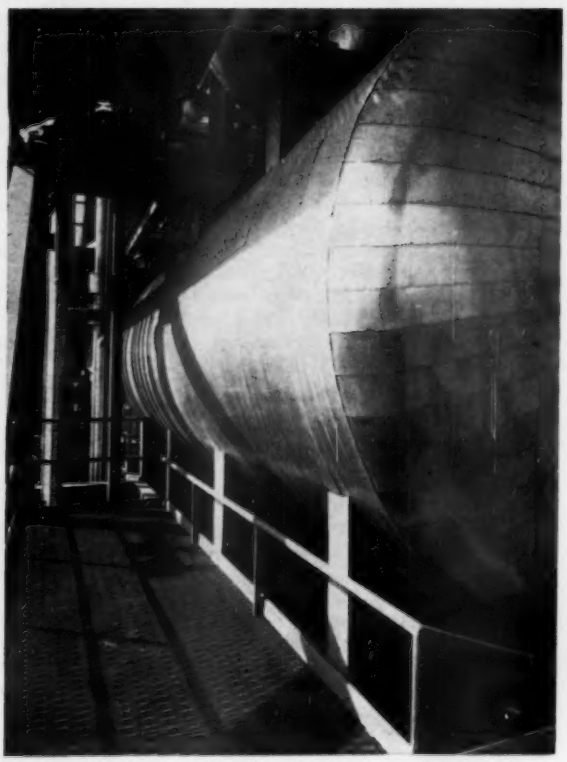


Stacks of aluminum apply, especially where flue gas temperatures are low or where excessive maintenance is to be avoided. These are 84 ft high, use 10-ft and 8-ft cylinders



Instrument tubing in aluminum has been commercially available for some time and may be used throughout the plant. This is view behind control panel in oil refinery

Pipe jacketing in Hawaiian Electric plant shows a popular use of aluminum. Used both for indoor and outdoor service, it gives good looks, weatherproofing, protection from abuse



Deaerator, insulated and jacketed with aluminum sheet. Note gore treatment on the head. Vertical tankage is often insulated with corrugated aluminum banded on over studs

Fig. 1. Leon E. Smith, Supt of Maintenance, closes damper on ventilation duct not in use. Such practices stop heat loss

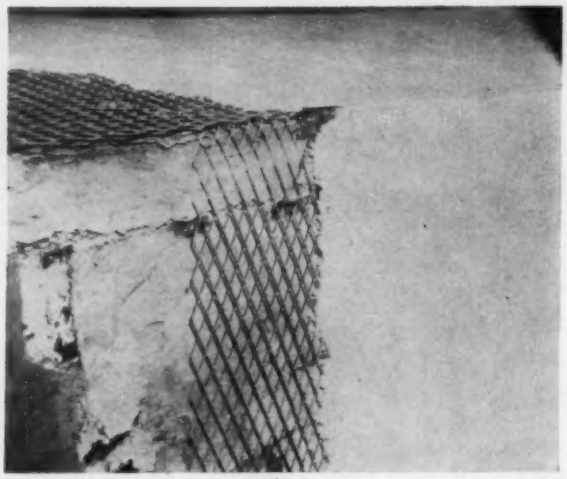


Fig. 2. Duct insulation under repair. Company practice calls for regular inspection of all insulation, and prompt repairs

Exide Captures the Calories To Beat the Profit Squeeze

Another of POWER ENGINEERING's conservation-of-utilities articles, this is a description of one company's effective efforts to conserve energy in the generation and use of process and space heat

By ARTHUR F. DeLONG*

AS A MANUFACTURER of "Package Power," Exide is naturally energy-conscious. When we instituted a "Capture the Calories" campaign several years ago, we attained cost savings in the high five-figure range. Three examples:

1. A saving of 25 per cent in heating-steam consumption, while simultaneously reducing unit generation costs.

2. A reduction in fuel and energy cost for plant hot water and process of considerable magnitude.

3. A reduction in strain on generating equipment, due to reduced loads, which reduced maintenance requirements.

In these days of rising labor and material costs, the engineer has an increasing responsibility in his company's "Beat the Profit Squeeze" campaign. At 10 per cent gross profit, $100 saved in factory operating cost is worth $1000 in order-take, and is there for the taking. And when business is off, and competition keen, reduced operating costs may permit the price reductions which enable your salesmen to keep your plant busy.

Cause of many of these profit leaks is often obvious. So obvious, in fact, that you may have grown accustomed to them, and fail to notice them. It takes a little time, a little walking (perhaps in the rarely-visited out-of-the-way places), to search out these loss-makers, but the savings made may continue 168 hours per week, for many years. Quite often, an annual return of 100 to 500 per cent on the repair cost is accomplished. Few other investments pay off as handsomely!

How Heat Leaks Away

Heat is expensive, yet it can be silently wasted in fantastic amounts. Hot water wasted may dribble profits away at three to five times the rate of cold-water waste. Those higher-than-necessary-temperature flue gases may drift away entirely unobserved. Unnoticed, uninsulated pipes in the rafters may be stealing profit dollars at the rate of several dollars per foot per year.

Those wisps of white steam that you see inside and outside your plant cost plenty — they might be sufficient to heat your house all winter. But the higher-pressure leaks, those that evaporate immediately without trace, and in noisy areas without being heard, are guilty of grand larceny!

Reduction of heat losses involves careful analysis in four areas. The more careful the analysis, the higher the savings will be.

1. Economy of generation — getting the most value from the fuel dollars you spend.

2. Economy of distribution — reducing losses while transmitting energy to its points of use.

3. Economy of use — squeezing the last Btu out of the heat delivered to plant or process.

4. Reclamation of waste heat discarded from plant or process.

At Exide, we do not believe in false economy in the purchase of equipment or controls for power plant or process use. We have found that often a few extra dollars in initial cost pays off handsomely by reducing operating cost, lowering maintenance cost, and evidencing ability to quickly track-down losses and operating problems.

For example, in our boiler house we meter steam output, water input, and all steam distribution, including that to power-house auxiliaries. Temperatures of air supply, feedwater, and flue gases are recorded. Feed-

*Exide Industrial Division, The Electric Storage Battery Co

water temperature is raised through blowdown heat exchangers and the use of air-compressor-jacket cooling water, saving both the water and its heat content.

Fuel is measured, using fuel-oil meters and coal-weigh larries. Upon installation or major repair to boilers or processing equipment, we get all details in top-notch condition. Then, by recording readings on all instruments, draft gages, and thermometers during tests that cover the full load range of the equipment, we develop operating standards. Then, for the life of the unit, we know how closely we are operating to peak performance. And, we know where to look for correction if efficiency falls.

Once steam has left the boiler nozzle, the heat that it contains attempts to escape in every direction. Every unnecessary insulated foot of pipe wastes heat. If uninsulated, it may waste ten or more times as much. Every uninsulated valve, fitting, or flange may waste as much heat as would several feet of bare pipe.

Economy of Distribution

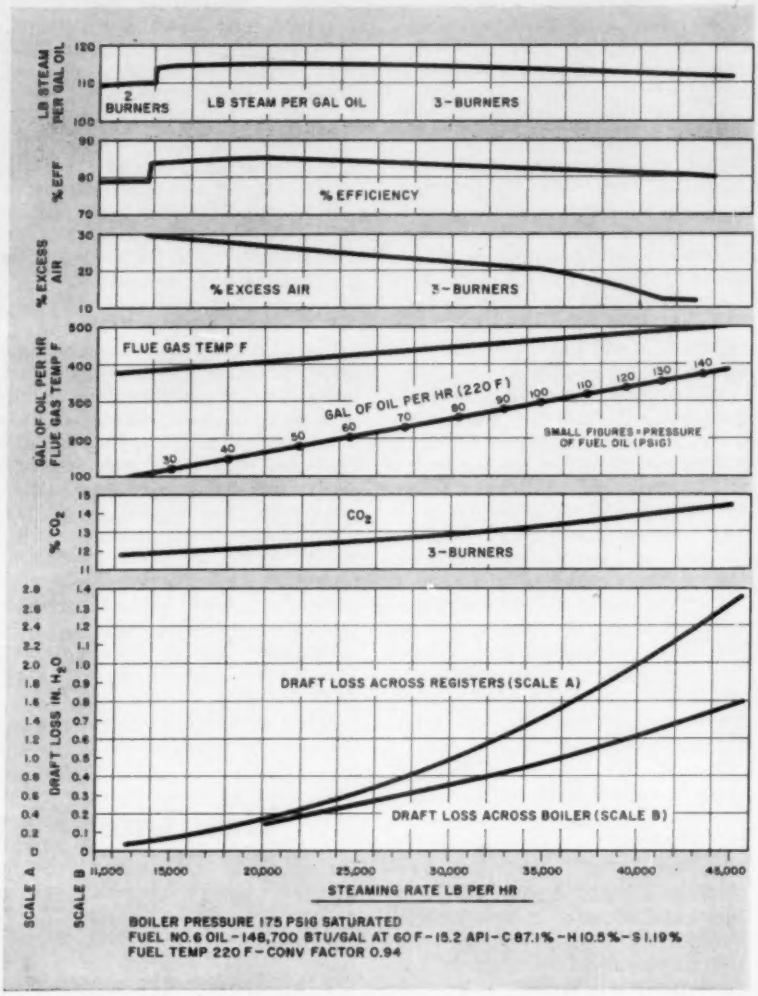
We have reduced distribution losses by shutting off mains or branches not in current use, and by investigating the use of other forms of heat where relatively-long lines are in use to supply small loads, even on a seasonal basis. Electrically-heated high-temperature oil can be circulated through jackets, to permit shutdown of a combined heat and process plant in the summertime, while in winter the fluid can be heated through a heat exchanger.

By carefully investigating process requirements, and providing improved controls, we were able to reduce considerably our steam generation and distribution pressures. This resulted in compounded savings — lower flue gas temperatures, and therefore higher generation efficiency, lower radiation losses from distribution piping, and reduced losses when leaks occur.

If there is a use for low-pressure steam in the plant, consider the use of flash steam from high-pressure condensate. Reduced heat losses from the condensate-return lines, or from the relatively-large low-pressure supply mains can be effected.

Institute a regular patrol of your distribution system and points of use. Stop, look, and listen for tell-tale wisps or hisses of escaping steam.

It is utter folly to neglect small leaks. To do so creates a "don't-care" attitude and lets these costly items become a normal way of life in the plant. While a 1/32-in. pinhole may only waste steam at the rate of $25 per year, the pinhole increases in size in short order. Then, the minor repair becomes a major job — a cut flange replaced, a valve body to be removed and replaced, a new expansion-joint sleeve needed. Furthermore, while these expensive repairs were being generated, losses above the cost of the minor repair may have been incurred every few days!


LB STEAM PER GAL OIL
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% EXCESS AIR
% EXCESS AIR
3-BURNERS
GAL OF OIL PER HR FLUE GAS TEMP F
FLUE GAS TEMP F
GAL OF OIL PER HR (220 F)
SMALL FIGURES = PRESSURE OF FUEL OIL (PSIG)
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DRAFT LOSS ACROSS BOILER (SCALE B)
SCALE A
SCALE B
STEAMING RATE LB PER HR
BOILER PRESSURE 175 PSIG SATURATED
FUEL NO.6 OIL - 148,700 BTU/GAL AT 60 F - 15.2 API - C 87.1% - H 10.5% - S 1.19%
FUEL TEMP 220 F - CONV FACTOR 0.94

Fig. 3. Performance curves for an oil-fired boiler. Through curves like this, it is possible to detect, at any load, deficiencies in operation, and correct them

Economy of Use

Proper trapping of process and heating units can reduce steam consumption, and most trap manufacturers' catalogs will tell you how. Provide test tees on traps or on return lines. These, temperature crayons and surface pyrometers, will enable you to rapidly detect passing or malfunctioning units.

Thermostatically control processes or plant heating to avoid overheating. Use modulating controls on gas and oil burners, instead of slightly cheaper on-off types, or set the low-fire setting close to the process demand. This reduces refractory repairs, decreases stack losses, and reduces heat lost in the off cycle.

Develop standards for plant heating. Know the heat input required under varying conditions of wind and weather, with plant not overheated, doors and windows closed, the heating system in top condition. In developing these standards, plan for night and weekend setback. Reduce temperatures in little-used areas.

Other Vital Points

Thoroughly clean heating surfaces, coils, and filters. Insulate roofs and walls where practical. Repair or seal leaky sash, broken or ill-fitting doors. Install automatic door closers. Check for inefficient heating devices — use downblow heaters to reclaim hot air from high ceilings, or use radiant heat or low-mounted forced-air units in high bay areas. Install ducts from

floor level to unit-heater inlets. Provide vestibules with interlocked doors, or air curtains at often-opened doors.

Reduce process exhaust ventilation to the minimum required. A saving of $50 per year can be anticipated for each 1000 cfm reduced, more in colder sections of the country. If exhausted air is contaminated and its temperature high (over 100 F), consider the use of air-to-air heat exchangers, such as thermowheels. Use scrubbers, filters, or activated carbon to avoid having to discharge heated air out-of-doors.

When your standards are developed, you will know how much inefficient practices or overheating are costing you. You may find it economical to provide supplementary heat for remote areas, occupied in normally "off" hours. You will have figures to back up your campaign against open doors, windows, overheating.

Don't overlook the advantages of metering steam and fuel to production departments and to individual major equipment. Unsubstantiated utility charges in operating department cost sheets are ineffective. Where these costs are prorated by formula among several departments, there is no incentive to control these items. Metering pins them down and gives the figures required to authorize major maintenance expense.

A circulating hot water system, by providing instantly-available hot water, avoids the common practice of leaving or blocking hot-water faucets on, so that employees won't have to wait a few seconds for hot water at shift change, or lunch periods.

Heat Reclamation

Reclamation of wasted heat can be a real dollar-saver. The use of heat exchangers to save the heat in exhausted air has been mentioned. This same principle can be applied to other locations. Flue gases from gas and oil burners can preheat combustion air, lowering fuel required. Hot wash-water discharge can preheat makeup water. The use of easily-cleaned platecoil heat-exchange units permits preheating, even with highly-contaminated or solids-bearing wastes.

Secondary use of warmed cooling water often requires a very little extra piping.

When planning for heat reclamation, we find it helpful to take a floor plan of the plant, and spot thereon sources of heat rejection, whether through exhaust, ventilation, cooling water, radiation from hot equipment or product, and heating units. On an overlay, we spot points where heat is needed (which may be continuous or seasonal), where fuel is used, and where wash or cooling water is needed.

In addition to savings from cascading washes, it may be found that warmed water wasted from cooling jackets may do a better job, and cooling water from one process may satisfactorily cool another. We found it practical to discharge cooling air from generator rooms, and ventilation from a piping tunnel, into our plant during the heating season. This provides warmed make-up air, reduces drafts from doors and windows, and reclaims 100 per cent of the heat that would otherwise be wasted.

Items mentioned on these pages are not spectacular and are normal good practice. In a new plant they can be provided for in the design stages. In the operating plant, however, urgency of installation of new equipment or equipment rearrangement often leads to cost-leaking conditions. THE END

New Diesel Backs Up Steam Plant

THREE NEEDS were fulfilled by the installation of a new 1280-hp opposed-piston diesel generator at the municipal power plant in Clay Center, Kansas, formerly an all steam plant. These needs were to improve operating flexibility, to handle peak loads, and to improve stand-by protection.

Cost reduction was not a primary objective, but this too has been achieved.

Corresponding with an aggressive campaign for new industry, this added capacity will assure adequate, reliable, cheap electricity.

New engine was installed in a separate building adjoining the existing steam plant, which consists of two 425-psig turbine generators, rated at 1500 and 3000 kw. A second steam plant contains three units, 500 kw, 1000 kw, and 1500 kw. The smaller two are now considered obsolete.

Diesel chosen by the city and their engineers, A. C. Kirkwood and Associates, was a Fairbanks-Morse Model 38KK8-1/8 dual-fuel engine, driving a 900-kw F-M alternator at 720 rpm. Though located some 50 feet from the other plant, it is possible to control the diesel plant completely from the steam plant, except for start-up.

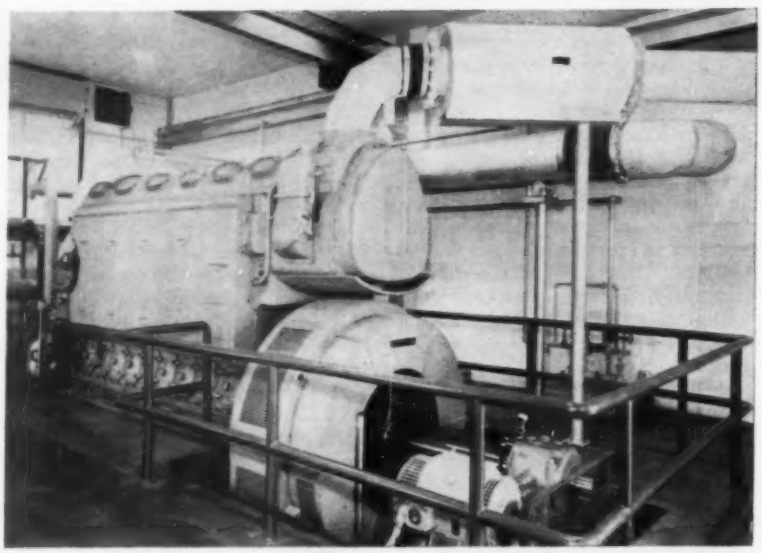
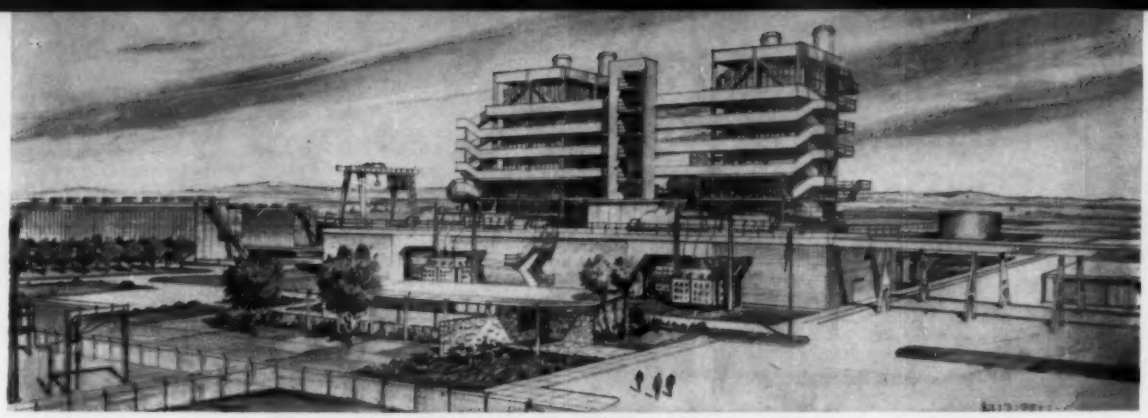


Figure shows new two-cycle diesel. Noise level equals that of the steam turbines

Since the first duty of the diesel is swift emergency service, tests have been conducted to show that an operator can trot over to the diesel plant, start the engine, get back to his switchboard, and put the generator on the line in less than two minutes. This provides the 125 kw needed to bring up another boiler at maximum speed, plus 775 kw for the community. The additional boiler can be in service in an hour — without the diesel it would take two or three times that long. Eliminating the former practice of keeping a boiler on stand-by saves $8000 per year.



Who Builds The Big Power Plants?

Did you ever wonder about the companies that specialize in building big power facilities? Modern plants become more complex every year, and the people who build them must be one jump ahead of new developments. Meet National Constructors Association

CHANCES ARE that most of the power plants you know were built by a member of National Constructors Association — an organization formed by major companies engaged in design and construction of specialized facilities such as power plants, chemical plants, petroleum refineries, and steel mills. Today there are 23 members and three associate members. Each is of major importance in its field; each operates on a national basis, and many work around the world.

History of NCA

NCA originated in 1946 with 14 charter members. Even though openly competitive, companies engaged in construction of complex industrial facilities such as power plants found they had many common problems, especially in the fields of labor relations and cost control. It became apparent that group action was the best solution.

Many fine trade associations were serving the industry, but none was geared to give special attention to the specific problems facing these companies. In late 1946, a few executives representing some of the larger construction firms met in Chicago. It was agreed that joint action was necessary, and a second meeting was scheduled.

In New York, attendance and enthusiasm grew, and conferees agreed to form the National Constructors Association. On April 1, 1947, the NCA began to function officially, with the opening of an office in New York.

Today, NCA operates through a seven-man executive committee and a small administrative staff headed by a full-time secretary. The New York headquarters acts as a clearing house for collecting, analyzing, and exchanging information on industrial construction practices throughout the United States.

This association acts only as a guide to members, and each company retains its freedom of individual action. Most of the problems are handled by committees. Presently, the NCA has committees working in the areas of labor, public affairs, safety, foreign affairs, and welfare. It is in the areas of labor and safety that NCA has attained its most notable accomplishments.

It was the NCA, through its Labor Cost Committee, that was the impetus behind the "Ten Commandments," a set of rules adopted by the Building Trades Department of the AFL-CIO to help eliminate featherbedding, unnecessary absenteeism, and other practices that cause construction costs to spiral.

The promulgation of this code was not an easy task. First, an exhaustive study was made of reasons for increased construction costs. These were cross-checked by locality, type of work, and type of problem. Thousands of individual cases were analyzed. When the final summary was completed, the documentation of existing inequities was strong enough to demonstrate forcefully that reforms were needed.

NCA Labor Committee negotiates nationally and regionally on behalf of its members and thus far results have been encouraging. National agreements have been signed by members with the Carpenters Union, the Operative Plasterers and Cement Finishers, the Ironworkers, the Sheetmetal Workers, the Operating Engineers, the Laborers Union, the Bricklayers, Masons and Plasterers, the Pipefitters and Plumbers, and the Boilermakers.

Other functions of the Labor Committee have been to set up sub-committees to act as a substitute for local employers' groups where no labor-employer negotiating apparatus exists.

Overseas Interest Growing

An area of growing interest to the NCA is overseas construction. The problems of the member companies are many and varied. To facilitate operations abroad the Foreign Committee makes studies and recommendations concerning specific problems.

Members of NCA are: Bechtel Corp; Blaw-Knox Co; C. F. Braun and Co; Chemical Constr. Corp; Day and Zimmerman; Machinery Div of Dravo Corp; The H. K. Ferguson Co; The Fluor Corp, Ltd; Ford, Bacon and Davis Constr. Corp; Foster Wheeler Corp; Girdler Constr. Div, Chemtron Corp; Hydrocarbon Research, Inc; Kaiser Engineers; The M. W. Kellogg Co; Koppers Co, Inc; The Lummus Co; Arthur G. McKee and Co; J. F. Pritchard and Co; Procon Incorporated; The Rust Engr. Co; Sanderson and Porter; Stone and Webster Engr. Corp; and United Engrs. and Constructors, Inc.

Associate Members are: The Babcock and Wilcox Co; Combustion Engineering, Inc; and Graver Tank and Mfg Co. THE END

CONSTRUCTION NEWS

Anchorage, Alaska — National Park Service, Anchorage, Alaska, has announced contract award to Reed & Martin, Inc, Box 569, Fairbanks, Alaska, in the amount of $533,862 for the construction of a boiler house, utilidor, and heating systems for buildings at Mt. McKinley National Park. Work will be carried out soon.

Phoenix, Ariz. — Arizona Public Service Co, 501 S. Third St, this city, has announced that company is currently negotiating with the Navajo Indians regarding the location of a coal-fired steam generating plant to be constructed in the four corners area of northwestern New Mexico. Utah Construction will operate nearby coal mines to supply the proposed facility with fuel. Plant is expected to have an initial capacity of 350,000 kw and is being scheduled for completion by mid-1962. This phase of the project, along with some 300 miles of transmission lines to connect with the company's system, will cost approximately $100,000,000. Company's new Ocotillo power plant at Tempe, Ariz, now under construction, is scheduled to go on line by May next year, with a total of 220,000 kw of generating capacity.

Little Rock, Ark. — Arkansas Power & Light Co, Simmons National Bank Bldg, Pine Bluff, Ark, has plans under way for the construction of a new administration and service center on building site in this town, to better serve company's customers in the southwestern area. Work will get under way at once for completion by late 1960 at a reported cost approximating $500,000. Work will be performed under the supervision of Erhart, Eichenbaum, Rauch and Blass, consulting engineers and architects of the new building.

Oxnard, Calif. — Southern California Edison Co, 601 W. Fifth St, Los Angeles, Calif, has announced that company has authorized plans and has begun construction of a $250,000 seawater distillation plant, capable of purifying 100,000 gal of water per day. Equipment for the pilot plant is being designed and fabricated by the Cleaver-Brooks Special Products Co, Inc, Waukesha, Wis, and will be delivered to the plant site adjacent to company's Mandalay Beach steam plant, located near here. Test operations are expected to begin this fall. Production will be experimental, and the water will be used to supply some of the steam station's needs as well as for research.

Bridgeport, Conn. — United Illuminating Co, 80 Temple St, New Haven, Conn, has announced contract award to the W. J. Megin Co, Inc, 51 Elm St, Naugatuck, Conn, for superstructure installation of second phase of second unit at power plant on the Pequonnock River in Bridgeport Harbor. Installation of a second steam-electric generating unit with a capacity of 150,000 kw is planned; it is scheduled to be in operation sometime in 1962.

Norwalk, Conn. — Connecticut Light & Power Co, 266 Pearl St, Hartford, Conn, has plans under way for a major addition and expansion program at its Keyser Island Power Plant in Norwalk Harbor off the shores of this city. Plans include the installation of a second steam-electric generating unit for increased generating output. Work on the new project, reported to represent an outlay of approximately $15,000,000, will get under way at once under the supervision of Kahn and Jacobs, New York, N. Y.

Dover, Del. — International Latex Corp, Playtex Park, this city, manufacturers of latex products, has plans under consideration for the construction of new addition to company's plant located here. Plans call for the erection of a new processing building, utility building, and a large new boiler plant with auxiliary equipment. Entire project reported to cost about $1,250,000. Work on the new addition will begin at once for completion by late 1960. A. H. Matts, Fort Myers, Fla, is the architect.

Bloomington, Ind. — The trustees of Indiana University, Bloomington, Ind, have announced a contract award to the Huber, Hunt & Nichols Co, Inc, Indianapolis, Ind, in the amount of $465,000, for power plant addition on University grounds. Work on the modernization of existing facilities and installation of increased generating capacity is under way and will be completed by late 1960.

Covington, Ky. — Union Light, Heat & Power Co, Fourth & Main Sts, Cincinnati, O., has authorized plans for the construction of rural distribution lines and electric substations, including miscellaneous gas and electric lines covering company's service area, at a reported cost of about $6,100,000. Construction of the new lines will begin late this year or early in 1960 for completion in about a year.

Louisville, Ky. — Louisville Gas & Electric Co, 311 W. Chestnut St, has authorized plans for the construction of phase number four of its Power Plant, located at River Rd and Cane Run Rd, this city. Plans call for the installation of a new steam turbine generating unit with a capacity of 125,000 kw, high-pressure boilers, and auxiliary equipment. Work is already under way under supervision of Pioneer Service & Engineering Co, Chicago, Ill, consulting engineers of the project.

Amherst, Mass. — Commonwealth of Massachusetts, Department of Education, Div of Building Construction, 38 Chauncey St, Boston, Mass., has authorized plans for the installation of two generating units for power plant at University of Massachusetts, this city, for increased capacity. Work, to begin soon, will include complete auxiliary equipment. Merrill Associates, Boston, Mass., are the engineers on the project.

Sewaren, N. J. — Public Service Electric & Gas Co, 80 Park Place, Newark, N. J., has announced that company has plans under way on a major expansion program of its Sewaren Generating Station, located here. Plans call for the installation of a new steam-electric generating unit with an initial capacity of 340,000 kw. When completed in 1962, this station will have a capacity of 817,000 kilowatts, the largest in the company's system, to date. Company has also announced that the second installation of a 290,000-kw generating unit at its Bergen Generating Station will be placed in service this fall.

New York, N. Y. — Consolidated Edison Co of New York, 4 Irving Place, New York, N. Y., has announced that the big utility is in the midst of a $210,000,000 construction program for 1959. In connection with this outlay, company has announced that a new 335,000-kw turbine generator will start operating shortly at its Arthur Kill station in Staten Island. In the spring of 1961, a 340,000-kw installation at the Astoria Station will go into service. In 1961, company's 275,000-kw nuclear fuel generating station at Indian Point is due for completion.

New York, N. Y. — Power Authority of State of New York, The Coliseum Tower, 10 Columbus Circle, New York, N. Y., has announced contract award to Emerson Garden Electric Co, Inc, 485 Lexington Ave, in the amount of $2,802,576, for the installation of a 345-kv transmission line from Niagara Switchyard to Rochester Station, Niagara and Monroe Counties. Work will get under way at once for completion by late 1960.

Dover, O. — Municipal Light & Power Department, City Hall, has announced plans for expansion in municipal power and light plant, with installation of equipment for increased generating capacity, including steam boiler and auxiliary equipment and boiler room. Complete work reported to cost in excess of $1,800,000. Work will get under way at once under supervision of William C. Kammerer & Associates, Cleveland, O., consulting engineers on the project.

Denison, Texas — Texas Power & Light Co, Fidelity Union Life Bldg, Dallas, Texas, has announced plans for the construction of a new steam-electric generating power plant on large building site just southeast of this town. Installation will include a 100,000-kw turbine generator unit and accessories, high-pressure boilers, and auxiliary equipment. Work on the new unit will get under way soon for completion late in 1961, at a reported cost in excess of $12,000,000. Plant area earthwork, grading, and leveling is already under way at a reported cost of $75,000; 138,000-v electric transmission lines, to connect with the plant, are also planned at a cost approximating $2,000,000.

Ephrata, Wash. — Public Utility District No. 2, Grant County, has announced that work is now under way on the construction of Wanapum hydroelectric dam on the Columbia River. Powerhouse will have a capacity of 832,000 kw when placed in operation late in 1962. F & S Construction Co, Ephrata, Wash., will do a major part of the contract work.

Glenrock, Wyo. — Pacific Power & Light Co, Public Service Bldg, Portland, Ore, has authorized plans for the construction of a second generating unit at its Dave Johnston Power Plant, located in this city. Construction of the new unit is already under way and is scheduled for completion by late fall of 1960. Unit will have an initial capacity of 100,000 kw. Original installation of like capacity began producing power for the area about six months ago.

Hall Industrial Water Report

VOLUME 7 OCTOBER 1959 NUMBER 5

Air Conditioning Means Water Conditioning

To the layman air conditioning means air cooling—nothing else. But the engineers who must operate large air-conditioning systems know the part that water plays in the condensers, air washers, humidity control and chilled water systems. They know too, that they need help to prevent the troubles with scale, corrosion and biological growths that occur wherever water is used.

Hall engineers are ready to give the help needed. They are trained to tackle the specific water problems encountered in air-conditioning systems, just as they are trained to assist you in making water in all industrial operations behave . . . from the source, on through boilers, service systems and process to final disposal.

Big Trouble With A Small Unit

When a Pennsylvania university installed a small air-conditioning system, operation was begun without water treatment. The water used was corrosive. After seven months copper condenser tubes in the refrigerating unit were pitted and perforated. So were steel condenser water boxes and baffle and the steel recirculating water receiving tank. Estimated cost of repairs was more than $10,000.

After this bad start Hall engineers were called. R. A. Danesi recommended replacement of the ruined copper condenser tubes with tubes made from a more corrosion resistant copper alloy. He also recommended conditioning of the cooling water with polyphosphate and set up rigid control of pH and blowdown. Two inspections during the next year revealed negligible loss of metal.

In this case, operating personnel were not aware of the necessity for water conditioning. Future trouble will be avoided by carefully following recommendations.

Dispersive Stops Scale

A Los Angeles building frequently had to clean heat exchangers in the air-conditioning system. The water, high in temporary hardness, attained a pH of 8.2 to 8.5 and produced calcium carbonate deposits when concentrated only one and one-half to two times. Treatment with the slowly soluble polyphosphate Micromet® largely eliminated the calcium carbonate but the system became dirty with calcium phosphate.

Hall engineer L. Arnold first considered reducing the pH of the water with sulfuric acid to stop the calcium phosphate precipitation. Building operators wanted to feed acid but the money needed to purchase feeding equipment was unavailable.

Arnold's next suggestion was to supplement the Micromet with some Hagan dispersive for minimizing accumulation of the calcium phosphate. This was done, and during the next air-conditioning season the heat exchangers were not once taken out of service for cleaning. When opened at the end of the season, they were found to be cleaner than they had been in the spring.

The Missing Bromide

Hall engineer G. E. Starr received a rush call for help from a southern hospital. Boiler water chloride tests gave results as high as 1000 ppm compared to a normal 100 ppm, even though the continuous blowdown valves were wide open.

The unusual condition set off a systematic search for the source of contamination. Plant testing was checked and found to be satisfactory. Conductivity tests on boiler water samples showed that the contaminant made up the major portion of the dissolved solids. This led the search to the zeolite softener used to treat makeup water for the boilers. No salt contamination of treated water was found.

The only place left to check was the condensate, which was found to be badly contaminated. A check of all sources of condensate ended at the absorption refrigeration machine where lithium bromide—not chloride—was leaking into the steam coils in the generator. The bromide was showing up in the chloride test.

Immediate repair of the leak not only stopped the contamination of the boiler water, but also the loss of expensive lithium bromide.

Absorption Refrigeration Machines

Absorption systems are very sensitive to scale. Temperature differentials across the condenser are not very great to begin with, and heat transfer falls off markedly as deposits accumulate in the condenser.

Formation of deposits is encouraged by the fact that the controls respond to light loads by reducing the flow of water through the condenser, rather than by cutting back the supply of steam to the generator. Water temperature rises and the formation of deposits is accelerated.

Serious corrosion of tube sheets in condensers and absorbers can occur because of galvanic action between copper tubes and steel tube sheets. Two methods of tackling this problem are to use corrosion resistant alloys for fabrication of tube sheets or to coat tube sheets with protective coatings. In addition, water conditions must be carefully controlled.

All of this points to the importance of water conditioning for uninterrupted operation. Engineers skilled in this work can be of real help to you.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve your particular water problems write, wire or call address below.

Water is your industry's most important raw material. Use it wisely.

HALL LABORATORIES
DIVISION OF HAGAN CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PA.
In Canada: Hagan Corporation (Canada) Limited, Toronto

Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

For more data circle 543 on Post Card

Safety Hazards from Bunker Fires and PC Firing

THE CHIEF was stressing the importance of eliminating bunker fires and pulverizer explosions by proper procedures. As long as there is fire in the bunker, there is danger of an explosion from combustible gases causing an initial explosion, followed by dust explosions. Saturated steam and CO_2 are effective in extinguishing bunker fires.

When hot coal is fed from a bunker to a pulverizer, it should be tempered with cool air to control the outlet coal-air temperature. In case the coal stops flowing from the bunker to the pulverizer, the pulverizer should be shut down and all coal valves and dampers closed and the pulverizers should then be inspected internally for fires.

After it has been established that no fire is present, the unit should again be placed in service until the bunker is empty. It is desirable to extinguish all fire in the bunker before it is empty. However, it is rarely possible to accomplish this. The use of steam and carbon dioxide in smothering a fire will greatly minimize the danger.

The cause of bunker fires should be established. This may be from already overheated storage coal but, more likely, it is because the coal has been kept too long in the bunker itself. Dead pockets within a bunker should be eliminated.

Care should be taken to avoid loading the bunker with overheated coal. No one should enter a bunker which is on fire, until the fire is extinguished and the gases generated have been dissipated. Even then, the man should be attended by a helper outside the bunker to whom he is connected by life lines.

The chief stated that a majority of these fires could be prevented if the firemen will coöperate with the coal passer and alternate pulverizers from side to side each night. Scale records indicate that the majority of the firemen are using the right hand pulverizer most of the time to carry the night load. This naturally leaves the left bunker idle, causing a bunker fire to occur.

The chief said that he did not intend

fold along this line—outside edges toward you

Based on sessions of the operators' training program conducted at Lakeside Station in Springfield, Illinois, by station superintendent F. H. Wilcoxen. Quiz No. 1—on lighting off a cold boiler—appeared last month.

to criticize the firemen, but in the past when burning down the bunkers where the coal is on fire, very little attention is paid to the fact that this is more hazardous than when burning fresh-mined coal. Boiler manufacturers recommend extreme caution during this procedure. The mill outlet temperature should be watched closely and atmospheric dampers opened to admit cool air to control same.

There's no worry about explosions in the mill when the mill is operating. Trouble comes after the mill is shut down full of coal by the previous fireman and he has not succeeded in shutting off the dampers and coal valves. This allows the hot gases to circulate through the pulverizer and start a fire in the pulverizing and burning system. This also happens when the exhauster and coal air pipes are not purged of all coal before shutting down.

Ball mills must be cleaned out if they are to be down longer than overnight. When burning a ball mill empty, the atmospheric damper should be opened to temper the hot primary air to keep the coal air temperature below 175 F, if possible. In no case should a ball mill be shut down with the coal air pipes and burners full of coal. They must be blown clean by increasing the exhauster speed.

After they are all clear, the coal valves and primary air dampers must be shut tight and the atmospheric damper opened wide. The hot gases must not be allowed to flow through a mill full of coal. This will start a fire in the mill which will then generate explosive gases. This will ignite from a spark caused by the tumbling balls when the mill is started and cause a violent explosion.

Dick: So you think it is practical to empty the ball mills before shutting them down every night?

Chief: The boiler manufacturers recommend it, and you know we do not have tight-fitting dampers and coal valves, so it may have to be done if we are unable to eliminate these explosions. If hot gases are leaking through a mill and you are unable to stop it, I would say the mill should be emptied.

Dick: It takes a long time to empty a mill and the temperature goes up over 200 F. It also takes quite a while to put an empty mill on. Sometimes you need them in a hurry.

Chief: If you open the atmospheric damper, can't you hold the coal temperature down when you empty the mill?

Dick: You can open everything and still can't keep the temperature below 200 F.

Chief: If a mill is empty you will not get an explosion when you start up, because there isn't any coal to generate gas which could cause an explosion.

Lon: What do you do when you come on duty and find the coal pipes red hot and the mill on fire?

Chief: Don't try to put the mill on or an explosion will result. Call for help to purge explosive gas from the mill with CO_2 or steam and extinguish the fire.

The chief went on to caution the firemen about operating the ball mills on one burner for long periods, when by shifting load, the mill can be shut down, saving power and wear on balls and liners and increasing coal air velocity in other pipes and burners and thus eliminating coal settling and drifting in pipes and burners. The same is true when operating on four burners at very light load.

Compact and completely pre-assembled, Inland Empire Paper Company's Package Air Preheater is ready to be connected to a 100,000 lb/hr boiler. This particular Package Air Preheater (incidentally a repeat order), measures approximately 10′x10′x8′, and its 7000 square feet of effective heating surface will recover about 360° F. from the stack gas. Package design cuts installation time and costs drastically.

Here's why
Inland Empire Paper Co.
chose a

PACKAGE AIR PREHEATER

BIG INSTALLATION SAVINGS — AND FUEL SAVINGS THAT CAN PAY FOR THE AIR PREHEATER WITHIN TWO YEARS.

Inland Empire Paper Company, Millwood, Wash., makes these big savings with their Package Air Preheater:

1. Low-cost installation. That single unit on the truck is a *complete* Package Air Preheater. Once in place, and the ducts and power line hooked up, it will be ready to go—installed without erection in a fraction of the time required for conventional units.

2. Short-term write-off. Records of Package Air Preheaters operating all over the country prove that Inland Empire's Package unit can pay for itself in two years, just on fuel savings alone!

You get this double advantage with the Package Air Preheater because it's completely shop-assembled. And its compact design brings all the advantages of continuous regenerative heat recovery to boilers as small as 25,000 lbs of steam per hr—or as large as 250,000 lbs per hr.

There are other important advantages, too. Get the whole story by writing today for your free 14-page booklet with all the facts and figures.

THE AIR PREHEATER CORPORATION

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Finding Air and Gas Flow Through Perforated Panels and Pipe

By JOHN D. CONSTANCE, P.E.

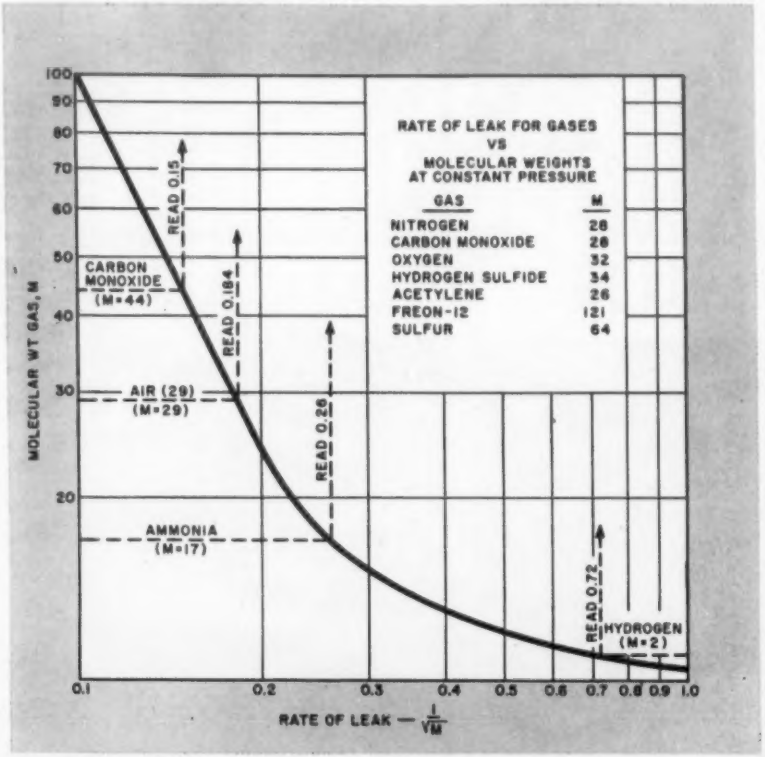


Fig. 1. Use this graph along with that of Fig. 2 to solve flow problems for gases other than air

THE LITERATURE carries considerable information on air and gas flow through orifices in pipes, but none is readily available on flow through perforated plates, panels, or pipe. To fill in this gap, the graph in Fig. 2 is presented.

Perforated thin plates are used as ceiling panels for distribution of conditioned air, distribution plates at the base of spray towers, or any other application where even distribution of air or other gases is required.

Although this graph applies to air, it may be used in connection with Fig. 1 to solve similar flow problems with other gases. Figure 1 gives correction multipliers to be used with the basic air flow determined from Fig. 2. Thus, for carbon dioxide the flow factor would be 0.15 (carbon dioxide)/0.84 (air) = 0.81. First find flow for air using Fig. 2, then multiply this value by the factor above.

Example: Ammonia gas at a static pressure of 0.10 water gage (w. g.), 20 per cent open area, find flow rate per sq ft gross area.

Answer. From Fig. 2 for air 175 cfm per sq ft gross area. Flow factor is 0.26/0.184 = 1.41. Ammonia flow rate then is

175 × 1.41 = 274 cfm per sq ft gross panel area

Note that plate curvature does not materially affect flow. Plate material may be steel sheet for air or stainless steel sheet for corrosive gases.

fold along this line—outside edges toward you

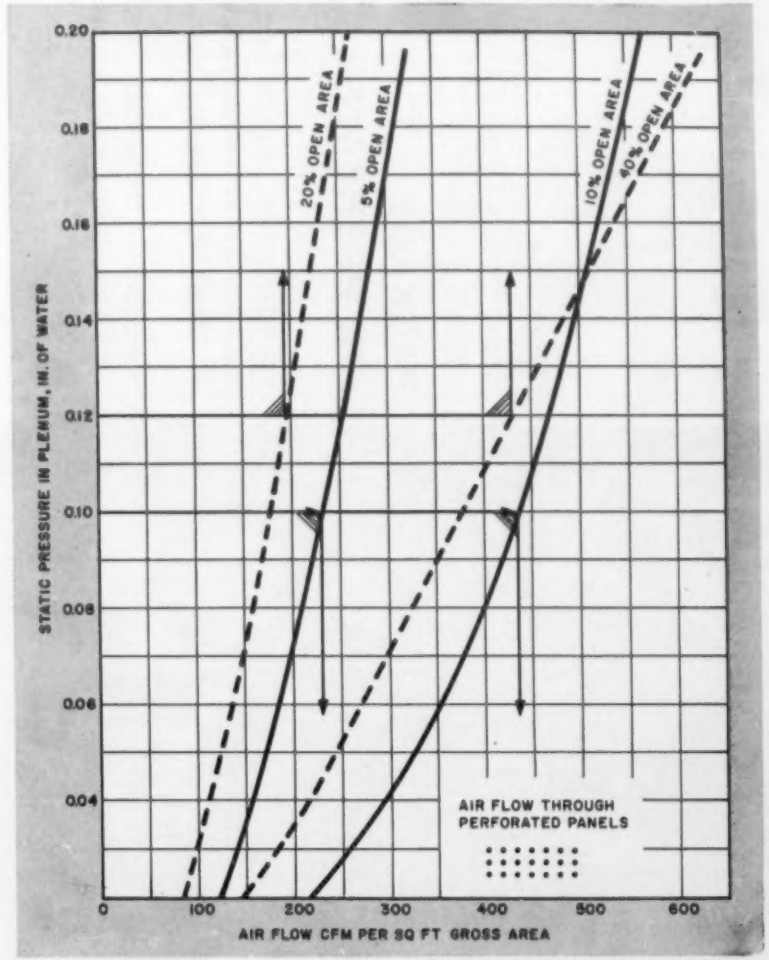
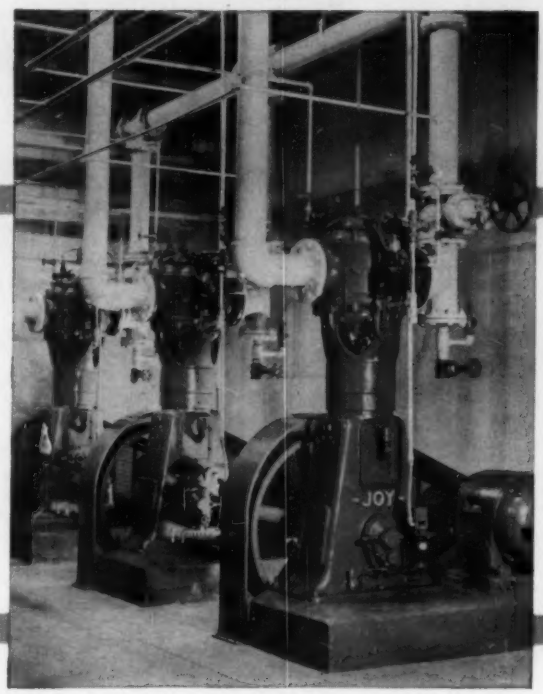

STATIC PRESSURE IN PLENUM, IN. OF WATER
AIR FLOW CFM PER SQ FT GROSS AREA
20% OPEN AREA
5% OPEN AREA
10% OPEN AREA
40% OPEN AREA
AIR FLOW THROUGH PERFORATED PANELS

Fig. 2. This graph applies to air flow, but with the correction multipliers supplied by Fig. 1 can be used for other gases. Conditions are for atmospheric air at 70 F and close to atmospheric pressure

FOR OIL-FREE AIR WITHOUT EXCESSIVE MAINTENANCE

JOY WGO-9 COMPRESSORS



A continuous supply of oil-free air is guaranteed by this multiple installation at a midwestern container factory. Vertical design means reduced maintenance . . . the piston ring need never be rotated.

This Joy WGO-9 supplies air free of contamination because it uses no lubrication in the cylinder. Lubrication is eliminated by the use of carbon-graphite or teflon piston rings. Exclusive piston ring design (patents pending) gives ring life of 8000 operating hours, and more. Joy has more than 20 years of experience with these special compressors, and as a result, has developed 14 sizes of the WGO-9 to meet your every requirement. Capacities run from 95 cfm—15 hp, to 939 cfm—75 hp. For larger volumes of oil-free air you can specify the WN series, up to 600 hp, 3696 cfm.

Get complete details on the Joy WGO-9, one of a complete line of compressors for industry. Write for free bulletin 337-56C.

337-607

AIR MOVING EQUIPMENT FOR ALL INDUSTRY

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

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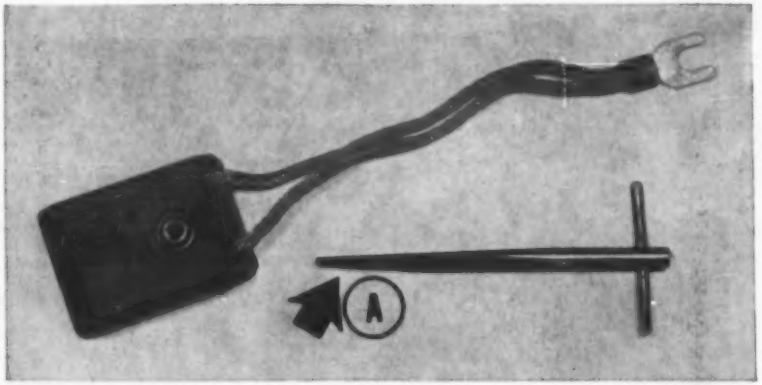


Check connection by lifting brush part way out of its holder, inserting small stud extractor tightly into inner diam of brush tubular rivet. Hand twist shows if rivet is secure. If stud extractor of suitable size is not available, use 4-in. extra slim taper file, A, mounting handle to prevent slipping. This works very well

Check Those Riveted Shunt Connections — Here's an Easy Way to Do It

By VERNON E. GARDNER*

RIVETED shunt connections of large brushes can be sufficiently loose to introduce high electrical contact drop, but at the same time not separate from the brush, thereby leaving a false impression of being in good operating condition. The high electrical contact drop throws additional current load on any other brush or brushes operating on the same brush arm, a condition which may cause streaking or grooving of the commutator and early failure of brushes. It is advisable, therefore, to make an occasional check test of these connections.

Simple way of making a quick but reasonably accurate test is to use a small stud extractor which will fit tightly into the inner diameter of a typical brush tubular rivet, as shown in figure. This can be accomplished merely by lifting the brush part way out of its holder, and does not require disconnecting of the brush.

A hand twist of the stud extractor will give an indication of whether the rivet is secure. If a stud extractor of suitable size is not available, a discarded 4-in. extra slim taper file may be used, provided the handle is mounted so as to prevent slipping. Care must be taken, however, lest a brittle file break and fall into the interior of the machine.

For a more accurate test of riveted shunt connections, the brushes should be removed and the millivolt drop between the shunt and the brush material measured when a current equal to 30 amp per sq in. of brush face area is passing from the shunt to a point near the brush face. Any brush which has a millivolt drop appreciably higher than the others should not be replaced in the machine.

*Electrical Engineer, Bureau of Ships

Reprints of Pump Maintenance Series

The 10 articles on centrifugal pump maintenance, by Cable and Kristy, concluded in this department, are being reprinted. For copies write The Editor, POWER ENGINEERING.

fold along this line—outside edges toward you

Test Set for Pneumatic Controls

By RICHARD P. HARRIS

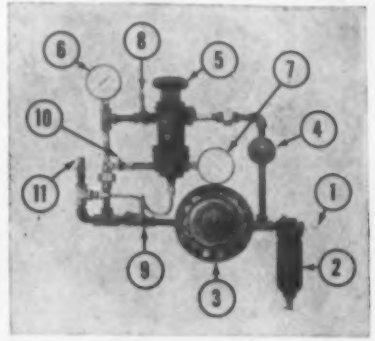
PNEUMATIC controls are very extensively used in power plants and other industrial establishments. Periodic testing and adjustment is necessary to keep them operating at top efficiency. To expedite this work in our plant we have assembled the Rube Goldberg contrivance shown in the accompanying figure. It is adaptable for use on controls which call for 60 psi and for the others, which use only 30 psi.

Hose attached to quick coupling, 1, supplies pressure at 100 psi from the main air supply. Air filter, 2, assures that only clean air will be supplied to pressure-reducing valves 3 and 4, set for 60 psi and 30 psi, respectively.

The control valve receives 30 psi air through upper cock, 8, or 60-psi air through the lower cock, 9. Gage 6 indicates which pressure is being used. By turning the knob of control valve 5 any desired reduction of pressure may be obtained and fed through cock 10 to the control unit under test.

If it is desired to introduce variations into the normal control air, this can be done simply by connecting the instrument control air line through cock 11 and closing cocks 8 and 9. Where supply is from 100-psi line, cock 11 may also be used as a pressure bleed-off. Pressure actually being transmitted to the instrument under test can be continuously read on gage 7. It is thus possible easily to observe the operation of the equipment being tested under any desired condition.

If pressures other than 30 and 60 psi are desired, the pressure-reducing valves can be adjusted accordingly.



This test set can easily be made up from parts that would be in stock in most plants

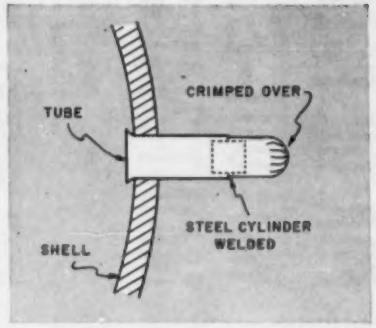
How We Repaired a Boiler Tube — Fast

By JAMES M. CURRAN

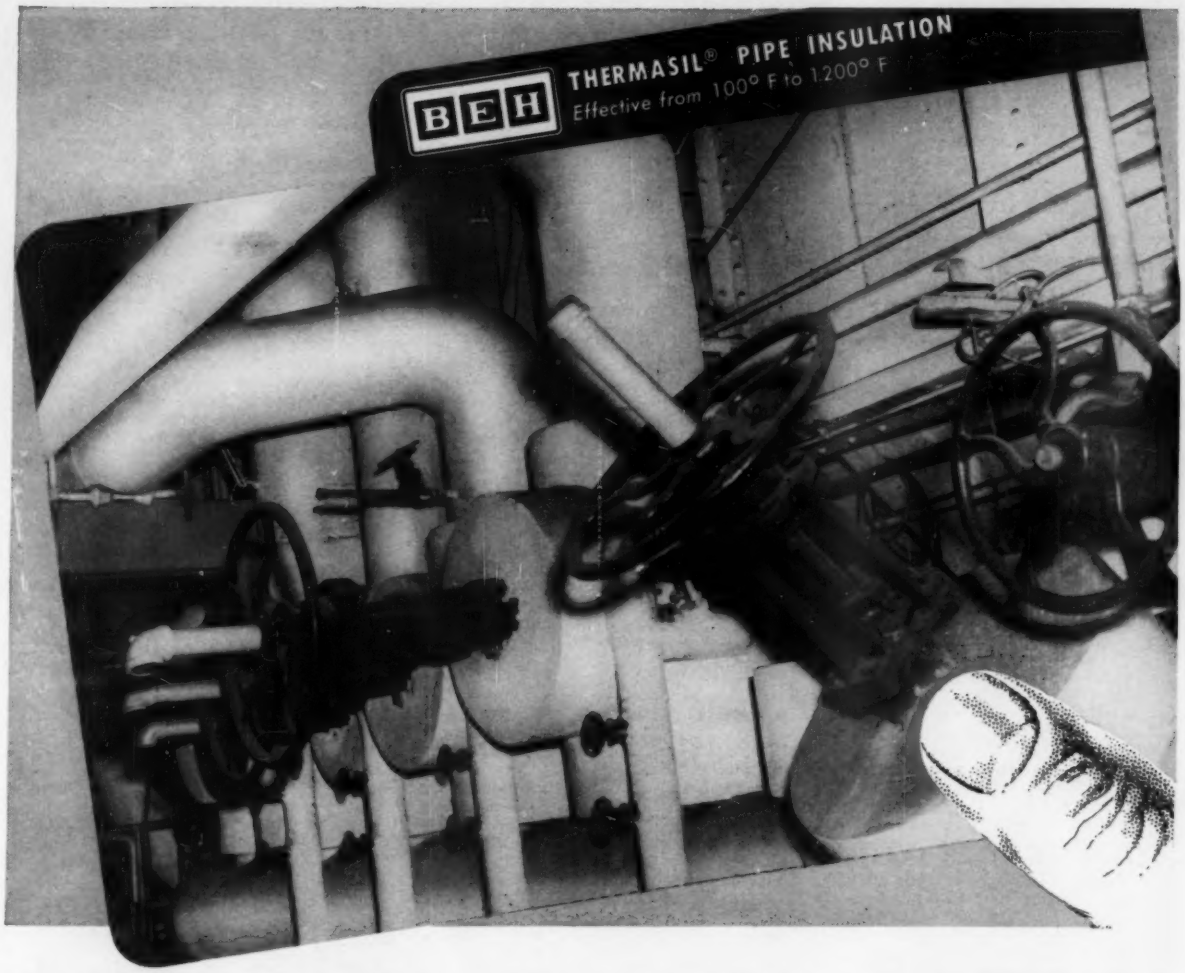
A PERFORATED TUBE in one of our water-tube boilers had to be cut out. We didn't have any bull-heads or plugs available, and as we were in a rush to get the boiler on the line, something had to be done fast.

The tube was burned off, about six inches being left in the shell. This part was heated for the entry or the insertion of a 3-in. steel cylinder (see sketch).

After the tube was cooled down, we filled it up with welding and crimped the ends over. Pressure test for leaks was then made on the boiler, and the work was found to be satisfactory.



This rapid tube repair worked well in emergency



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They certainly are saving money — and you will too — with THERMASIL in application, low maintenance and long service life. As a pipe insulation, it is molded — not machined — to exact finished sizes. This assures that both inside and outside surfaces are tough, smooth and dust-free with dimensions held to close tolerances, providing a tight, uniform fit. THERMASIL is exceptionally light in weight, permitting easy and fast application; is readily cut, sawed, scored, drilled with standard tools — no special fabricating equipment required. It is unaffected by water or weather; has high structural strength — good for the life of the equipment it insulates. For information on B-E-H THERMASIL and other dependable B-E-H Insulations, write for catalog. Contract application service available in 48 states.

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EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 123–124 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—ALUMINUM ACCESSORIES for bare electric conductors

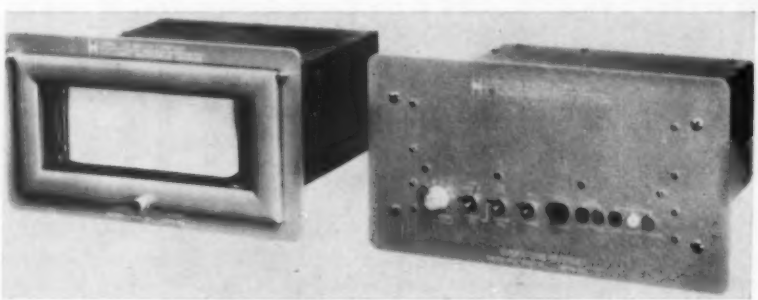
For use with stranded aluminum and A.C.S.R. (aluminum conductor, steel reinforced), these tubular wrought aluminum accessories for bare electric power conductors — including joints, deadends, jumper terminals and repair sleeves — are fabricated from drawn tube. Standard sizes range from 336.4 M.C.M., 26/7 A.C.S.R., through 1,590 M.C.M., 54/19 A.C.S.R. According to company, handling and installation advantages result from tubular design. Cable insertion is facilitated by smooth interior surfaces of drawn bore. Standard bolt hole spacings permit interchangeability, so that all jumper terminals fit any deadend body. For special installations, the tongue may be positioned radially about axis of conductor prior to compression. In addition, 15-deg angles on both deadend tongues and jumper terminals, allow jumper loop to be placed in either perpendicular or 30-deg position with same accessories. Aluminum Co. of America.

3—LIQUID dries out, moisture proofs electrical equipment

Application of CRC Moisture Inhibitor is claimed to eliminate harmful effects of moisture in electrical equipment — to drive out absorbed moisture and keep it out. Electrical characteristics, which deteriorate in moist and humid atmospheres, are restored by this treatment, says manufacturer; and even equipment that has been totally submerged can be put in operation quickly. Although non-conducting, CRC does not interfere with conductivity of contacts or commutators, it is pointed out, and it prevents corrosion of metals with a continuous molecular film that blankets the surface. Immersion, pouring, brush or spray methods can be used with this liquid, and under most conditions an application will provide a year's protection. Corrosion Reaction Consultants, Inc.

4—NON-SKID SURFACING for the hazardous floor areas

Chemi-Top Safety Floor is described as a non-skid resurfacing compound that is chemically inert and trowels to a tough topping for areas covered with grease, acids, alkalis and other hazardous liquids. It contains a sharp aggregate that penetrates oil films and makes a firm contact with workers' shoes. It is suggested for ramps, dockboards, stair treads, catwalks. According to manufacturer, this surfacing resists corrosive effects of oils and greases almost indefinitely. The Garland Co.



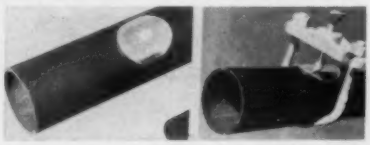
2—OPERATIONS RECORDER is compact, rugged instrument

This operations recorder operates only upon a change in the incoming signal in either analog or digital channels. It is suggested for use in power, chemical processes, metalworking and other industries concerned with monitoring digitized or sequential data or special forms of analog-type data. An electrosensitive record, for instant viewing, is produced by self-contained transistorized sensing circuits powered from an internal rechargeable nickel-cadmium battery. Recorder and control unit together require space of 17-by-17-by-17 in. There are no adjustments to make, manufacturer points out, and test controls are self-returning to operating position.

There are six off-on channels and one analog (digitized) channel. Record loading is through front panel. The chart is 3¾ in. wide. Marking is by fixed styli, each excited from its controller. The instrument operates at standard chart speeds. Frequency response is 0-600 cps for the analog (digitized) channel and 0-200 cps on the off-on channels. The time at which an automatic record is taken is indicated electrically on the chart. Time is printed in binary form to nearest minute. Hathaway Instrument Div., The Hamilton Watch Co.

5—REPAIR METHOD stops pipe leaks without shutdown

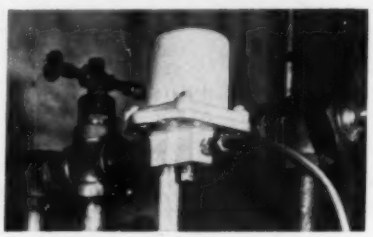
Small leaks in fluid or gas pipe lines can be repaired by this method utilizing a permanent pipe patch and a tool — without shutting down the line. The patch (individually contoured to fit



each size of pipe and furnished with bonded Neoprene gasket) is placed directly over the leak, then held in place by the tool. When sufficient pressure is applied to the patch by this tool, the leak is sealed off. Once the leak is sealed, you can weld the patch on the pipe for a permanent repair, or leave the tool in place for a temporary repair. The tools, which may be reused indefinitely, are "hold-down" clamps of saddle type (shown) for ¾- through 6-in. pipe, chain type for 7- through 36-in. pipe. M. J. Crose Mfg. Co., Inc.

6—INSTRUMENT measures gas, fluid or vapor pressures

Model 328 Resistance Pressure Detectors measure gas, fluid or vapor pressures in combination with company's Omniguard monitor. Pressure is converted directly to an electrical resistance. The detectors are described as rugged, accu-

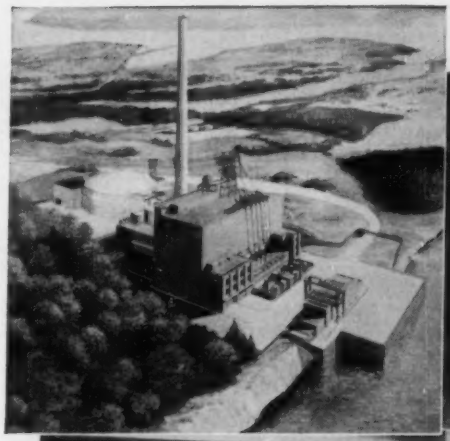


rate, inexpensive. A variety of ranges is available so that low pressures, measured in inches of mercury, to pressures of 3000 psi can be watched constantly on the same Omniguard instruments that monitor critical temperatures.

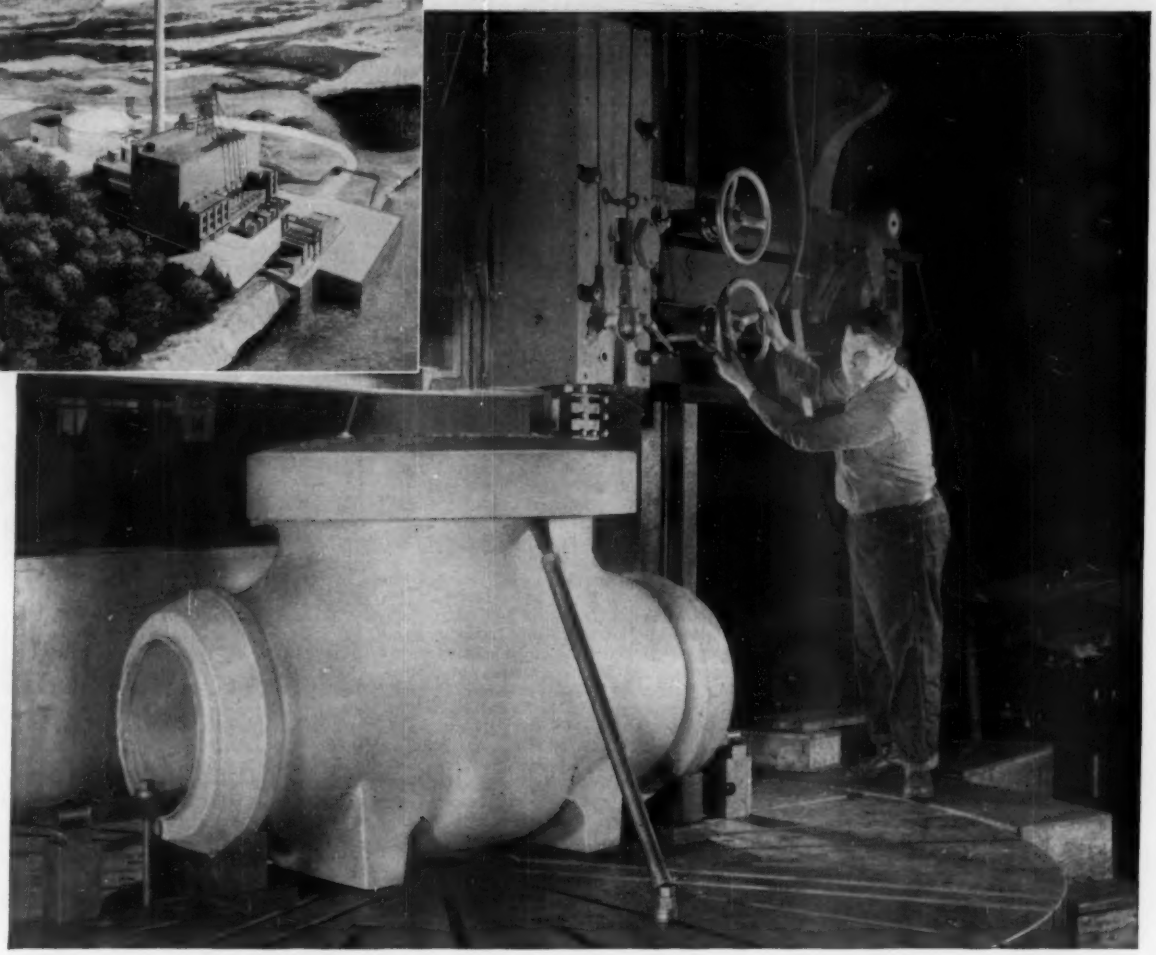
For pressures under 30 psi, a precision capsule is the sensing element. From 30 to 3000 psi, Bourdon tube elements are used. The pressure sensing element linearly varies the terminal resistance of a low temperature coefficient alloy winding to permit operation over ambient temperatures of 32 to 150 F. Model 328 is 2 5/16 in. in diameter, 2⅛ in. long. It is normally mounted in a pressure detector head, as shown. Bulletin 3051 gives details. Thomas A. Edison Industries, McGraw-Edison Co.

7—TIME SWITCH offers 40-amp tungsten rating

This 40-amp, tungsten-rated time switch, the 4000 Series, is announced for all lighting applications from incandescent to neon, and for use with pumps, blowers, motors, heating and air-conditioning, signal systems, filter systems. Significant development reported is a 40-amp tungsten rating which provides the highest capacity available in general



Indian Point nuclear power plant as it will look when completed for the Consolidated Edison Company of New York, Inc.



Machining 5½-ton Type 304 stainless steel body casting for one of the Indian Point valves. Completed valve will weigh approximately 12 tons. Crane maintains complete facilities for making nuclear valves—including the most advanced scientific methods for rigorous inspection, and testing on hot and cold loops.

8 Giant Crane Valves for Indian Point Atomic Plant

Crane is selected again! Our big Chicago works, with facilities for making valves from the smallest to the largest, is taking in stride an order for eight 24-inch stainless steel gate valves—the largest of their kind ever built.

These valves are for installation on the four main coolant loops serving the pressurized water reactor at Consolidated Edison Company's Indian Point nuclear power plant in Westchester County, New York.

Crane offers you the experience, engineering and metallurgical knowledge, manufacturing skill and plant facilities that have produced valves for such important atomic power projects as the Navy's fleet of nuclear-powered submarines and surface warships . . . the nuclear cargo ship *N/S Savannah* . . . the nuclear power plant at Shippingport, Pa. . . . and the EBWR at Argonne National Laboratory.

Write today for detailed information.

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Illinois—Branches and Wholesalers Serving All Areas

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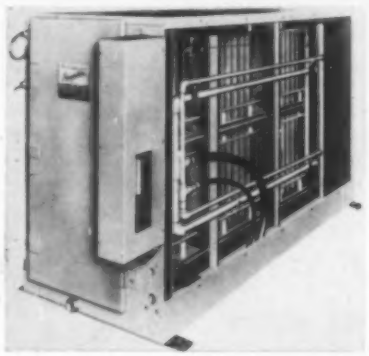
purpose low-cost time switches, company says. The 40-amp rating is said to eliminate troubles caused by contact welding. Other features include "snap-out" movement permitting quick removal of entire movement and a spring clutch which allows dial to move freely for checking "on" and "off" switching operation. Paragon Electric Co.

8—INDICATING RELIEF VALVE "tells on" high pressure

Compact size, variable relief pressure adjustment and continued indication of operation even after pressure has returned to normal, suggest the Demi Tattle-Tale for applications where it is important to know if pressure has opened the valve even momentarily. It features an indicating pin designed to pop out of the compact body the instant the valve opens. The red anodized pin remains in out position until manually reset; it shows at a glance that preset pressure has been exceeded, even after the condition subsides. The Demi Tattle-Tale has a pressure adjustment screw on the top of the bonnet and can be had for relief settings from 3 to 100 psi. It can be used in conjunction with micro-switches for additional signaling methods. These valves are available with NPT connections from $\frac{1}{16}$ to $\frac{1}{2}$ in. George W. Dahl Co., Inc.

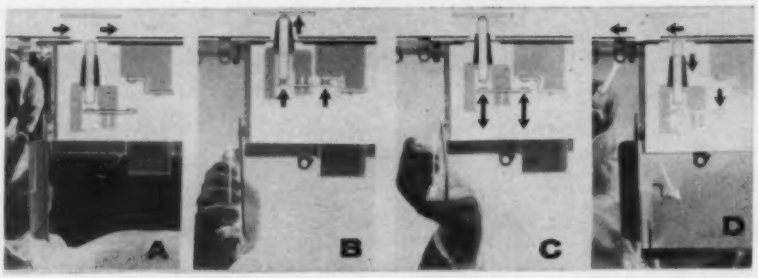
9—AIR CLEANERS designed for "in-line" assembly

Electronic air cleaners in this manufacturer's Precipitron line are available to match style and dimensions of company's air distributing units and can be assembled "in line" by bolting directly to them — becoming part of an integrated system for central plant air



conditioning, heating and ventilating. The cleaners are for application at conventional coil face velocities between 350 and 600 fpm for capacities from 1950 to 28,800 cfm. They are only 25½ in. deep in the direction of air flow.

Collector plates can be washed manually or automatically by a moving nozzle — collected dust can be flushed away without need to enter the ductwork. With use of Dustik, a cold water soluble adhesive, hot water is not required for washing. Installation of these Precipitrons is simplified because they are factory built, ready for floor, platform or ceiling. Much of the conventional high-voltage wiring has been eliminated in these units — only high-voltage connection is from the power pack to a terminal on the cabinet. Sturtevant Div., Westinghouse Electric Corp.

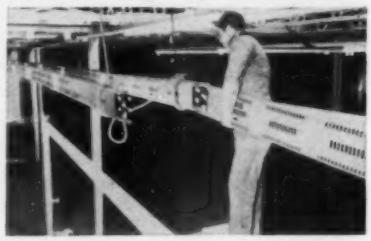


10—PRE-FAB SYSTEM offers safer electrical distribution

Foremost advantage of the Uni-Bus Masterguard System is safety. According to manufacturer of this pre-fabricated distribution system, it is impossible to touch a live part anywhere in it, because of its safety slide and retractable plug-in contact operation. This mechanism is designed to provide three-step safety; the safety slide covers bus bars and can't be opened until plug-in unit is installed on busways; when plug-in unit is installed and safety slide is open, interlocks serve to prevent removal of plug-in device; retractable stabs make contact with bus bars when handle is "on" and door to plug-in unit cannot be opened.

As illustrated, plug-in devices clamp to energized feeder or other power-carrying device in the system. Release pins on plug (A) clear safety slide interlock, which is moved to open position. Plug-in unit is now interlocked to outlet. When operating handle is closed (B), primary contacts close inside switch, completing circuit. Switching operation opens secondary contacts only (C). Primary contacts are not released or removed to lockout position until handle is "off" and cover opened. Switch must be "off" and slide closed (D) to remove plug.

Total safety is not limited to busways, it is stated, but is carried throughout the system to bring the identical safety slide outlet down to working level in motor control centers, switchboards, motor starters and enclosed switches. Other advantages announced for the system include efficient power transmission, "shelf-engineered" availability due to



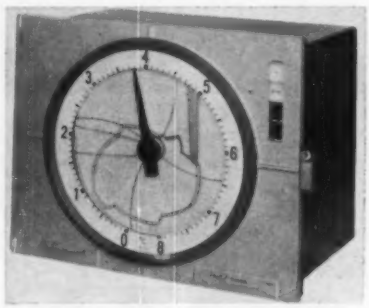
use of standardized components, lower costs, and simplified design. All components have common electrical ratings and physical dimensions, and standardized sub-distribution centers receive a variety of plug-in units to make them perform the same electrical functions of several products in many systems. Electric Distribution Products, Inc.

11—GRAPH-GUIDED PROGRAMMER records process performance

The PreKorder is a programming-controlling-indicating instrument designed to simultaneously "read" a pencil-drawn program chart, control a process accordingly, then superimpose a record of process performance on the same chart. It differs from conventional chart recorders by its absence of cams, cam followers and function generators. Significant cost savings are attributed to elimination of these. The program appears as a double-line graph, pencilled on the recording chart. The controller, sensing any deviation of the recording pen from the middle of the pencilled graph, regulates the process to oppose the deviation.

Two parallel lines defining the process program are connected electrically to the ends of the center tapped transformer winding which serves as a voltage source for an electrostatic field between lines. The pen, serving also as capacitive probe, picks up an error signal proportional to any deviation of the pen from its null balance position. This error signal is used to effect a readjustment of the process in the proper direction. According to manufacturer, this technique of direct error signal derivation joins the programmer, recorder and process itself into a closed-loop control system.

With the PreKorder, process programming is done by drawing a double-line graph of the desired program on ordinary chart paper. (The program may be changed by erasing and redrawing.) A record of process performance is superimposed on the process program chart for visual comparison of actual and desired operation. Since the pen senses its position between chart lines without touching them, the chart may be overlayed by clear vellum paper on which the ink record is made. Thus, the master chart may be used repeatedly, with only the overlay changed after each recording. Use of an overlay also permits introducing variable programmed process



limits by pencilling in boundary lines. Push-button switches may be used singly or in combination to provide indication only, indication and recording with or without chart advance, set point

New Nalco Coagulant makes Larger, Heavier Floc . . . Faster

Radically different Nalcolyte 110 used with Conventional Chemicals to Cut Costs, Speed Action in Water Clarification

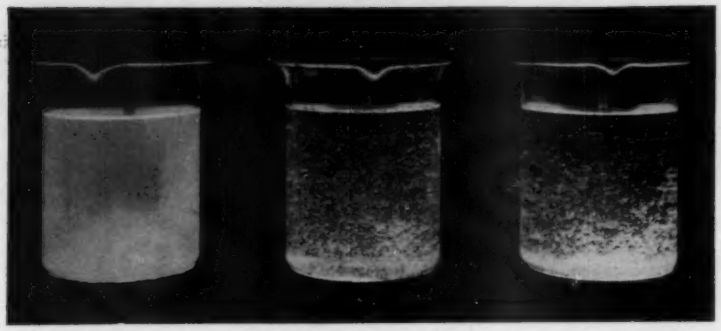


Photo taken in Nalco Laboratories 7 seconds after agitation stopped: *Left*, Control sample of untreated turbid water; *center*, same water, treated with 50 ppm alum; *right*, same water, treated with 20 ppm alum, 1 ppm Nalcolyte 110. Note that large, dense floc is settling out much more rapidly than center alum-treated sample.

Nalcolyte 110 is a new, non-ionic high polymer flocculant of very high molecular weight—over 1,000,000. It is used in extremely small dosages with conventional coagulants (such as sodium aluminate, alum, ferric sulfate) to increase size, density and uniformity of floc.

Less Chemical; Greater Capacity

Action of Nalcolyte 110 in creating heavier, larger, faster-settling floc not only permits greater throughput rates without floc carryover to processing equipment, but also cuts the total chemical requirements at a resultant cost saving.

In the example illustrated above, only 40% as much alum is required when Nalcolyte 110 is used.

May be Used in Potable Waters

Approved by the U. S. Public Health Service Technical Advisory Committee for use in treatment of public water supplies, Nalcolyte 110 gives water works the opportunity to get appreciably greater capacity from existing clarification equipment—at lower treating cost.

High Suspended Solids No Problem

Waters containing high suspended solids respond quickly to Nalcolyte 110 coagulating action . . . frequently without other coagulant chemicals.

Typical high suspended solids waters which can be treated with speed and economy with Nalcolyte 110 are paper mill white water systems, industrial waste waters, mineral slurries and blast furnace gas wash water slurries.

Nalcolyte 110 Easy to Handle

Nalcolyte 110 is a coarse, white, free-flowing powder of non-toxic character. It is fed in dilute water solutions with standard liquid proportioning pumps or feeders. Stock solutions are prepared at concentrations up to 20%. Packaging is in convenient 25-lb. bags.

Data Available Promptly

Full information on Nalcolyte 110 for your coagulant use is ready to be sent upon your request. Write today, or call your Nalco Representative.

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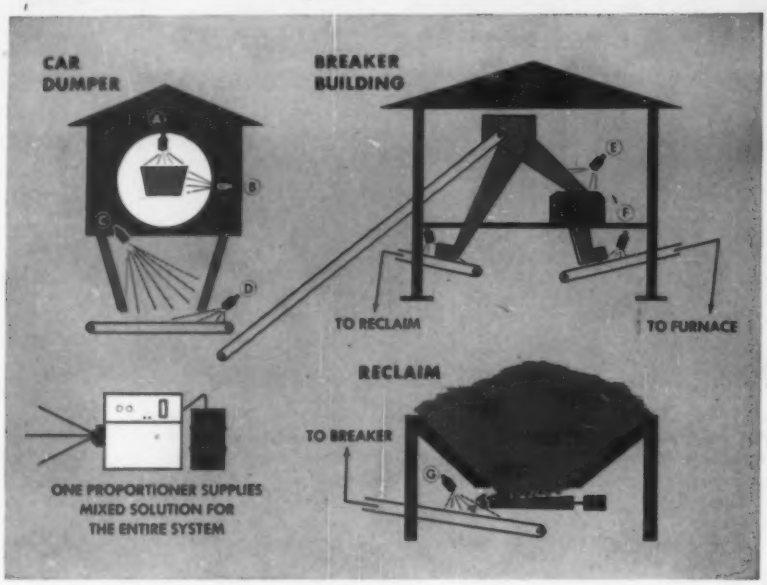
Nalco CHEMICALS

JOHNSON MARCH chem-jet DUST CONTROL SYSTEM



EFFICIENT DUST CONTROL IN COAL HANDLING GIVES 3 BIG COST SAVINGS... *plus protection against coal dust fire and explosion hazards*

Low First Cost:

You can buy a Chem-jet system at 1/10th the cost of dry collection systems. At the same time Chem-jet is guaranteed in most installations at least 90% efficiency.

Low Operating Cost:

Chem-jet operation costs only about 1/10th to 1/20th of a cent per ton of material treated.

Low Maintenance Cost:

Durable, foolproof Chem-jet systems need only a minimum of upkeep compared to other systems with hoods, ductwork, fans, larger motors, etc.

Dust Never Gets Airborne with Chem-jet

Chem-jet suppresses all types of air borne dust at its source by treating dusty materials with a Compound MR—a surface active agent . . . Investigate economical, flexible Chem-jet by writing today for latest bulletin. Johnson-March Corporation, 3018 Market Street, Philadelphia 4, Penna.

JOHNSON MARCH DUST CONTROL ENGINEERS

CANADIAN REPRESENTATIVES: G. F. STERNE and SONS LTD., BRANTFORD, ONTARIO

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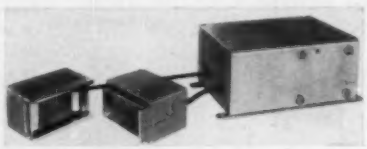
control and indication, program control and indication, and program control, indication and recording.

The PreKorder is adaptable to processes which may be electrically controlled and monitored by a transducer mechanically or electrically connected to the recording pen. Examples are in programming and control of temperature, pressure, voltage, power, liquid level, humidity, flow, pH, position, speed, force. Circular- and strip-chart types are available in a broad range of scales, speeds. Research, Inc.

12—SAFETY LOCK guards against "unsafe" start-ups

The Lance Lock is designed to prevent starting of electrically powered or operated machines, apparatus or equipment — unless the safety door or guard is automatically locked in place. It also serves as a protective device for high voltage equipment. The lock consists of



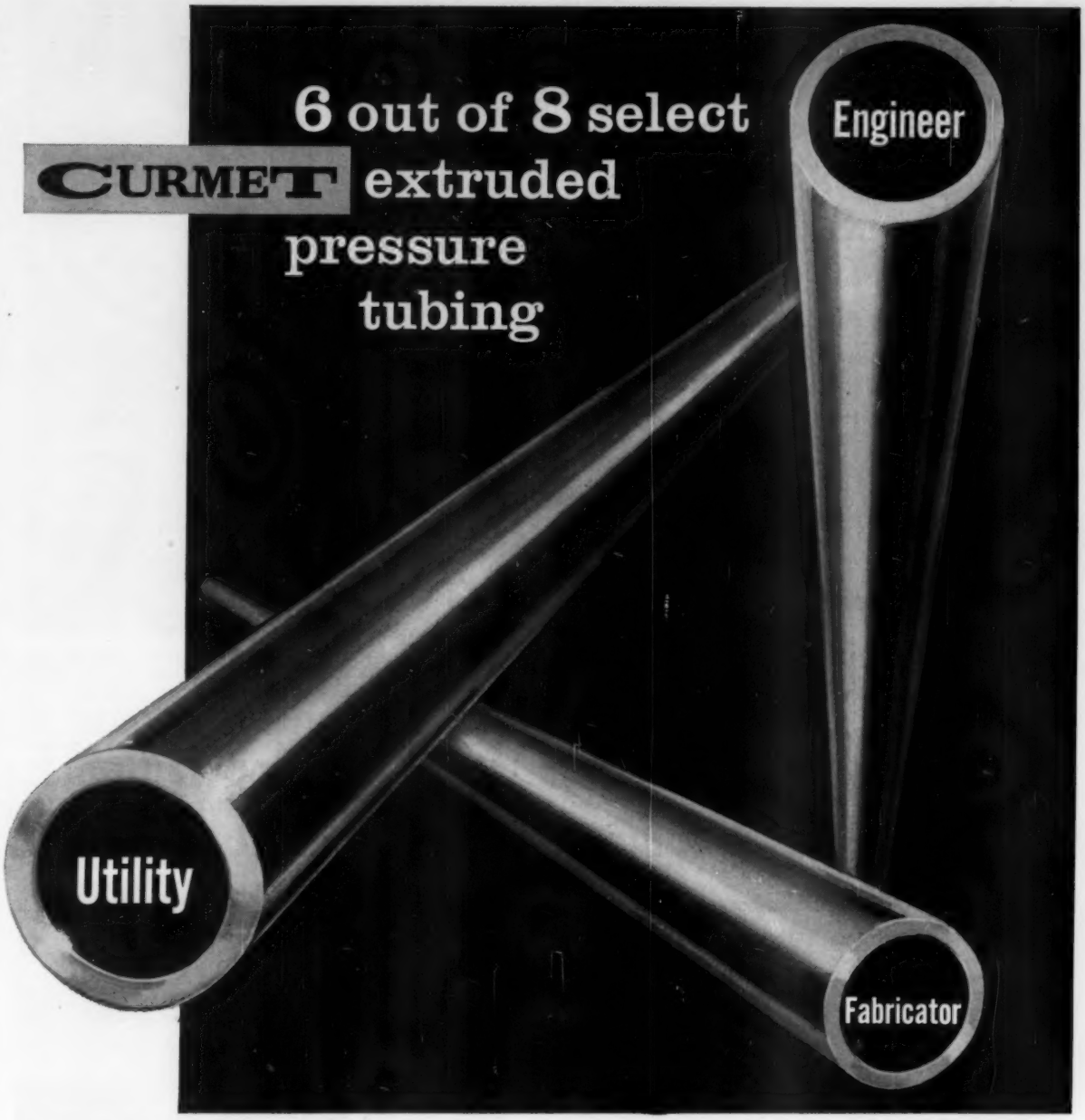
a split transformer, one half of which is fastened to the machine itself and the other half to the access door, operating lever, handle or other closing means. Only when both halves of the transformer are properly mated can the machine starting switch in the main circuit be closed. Likewise, the guard or door cannot be opened until the machine has been switched off.

The lock is so designed that when the two transformer halves are properly brought together and the starting switch turned on, the pivoted half of the transformer is attracted to the other half, mechanically locking both together, so that no lateral movement is possible. This also allows enough current to be generated in the secondary winding to close the machine power circuit. Lindly & Co., Inc.

13—FORMABLE METAL PACKING serves many applications

Lonsor is described as a metallic packing suitable for high pressures and temperatures which never needs replacement, since it doesn't deteriorate or

harden. Lonsor comes in 1-lb cakes. You break it off and stuff into the box, gland or shaft by hand. Its inherent self-lubricating properties, derived from its antimony content, result in frictionless running, according to manufacturer, and because of its pliability, it compensates for inequalities in worn or out-of-round shafts. Acid free itself, its lead base



Six out of eight contracts recently awarded for new power plants specified Curtiss-Wright extruded pressure tubing for steam and reheat lines.

Utility, engineering firm and fabricator select CURMET tubing because its longer length reduces welds —because the metal itself is improved by the exclusive extrusion method. For example, keeping metal under 24,000,000 pounds compression forces flow in both axial and radial directions so that transverse and longitudinal strength are nearly the same.

The foresightedness of public utility management leads to the specification of materials that will stand up under ever-increasing operating temperatures and pressures. And equally as visionary are the engineering firms and fabricators who assist in the design and construction of these power plants for the decades to come.

CURMET tubing, from 8″ to 20″ OD, is available in premium grade carbon steels—chrome-moly, stainless and similar quality alloys.

Write for more complete information on this CURMET process—the superior properties—and the premium quality that it gives to metals.

CURTISS-WRIGHT CORPORATION 91 GRIDER STREET **METALS PROCESSING DIVISION** BUFFALO 15, NEW YORK

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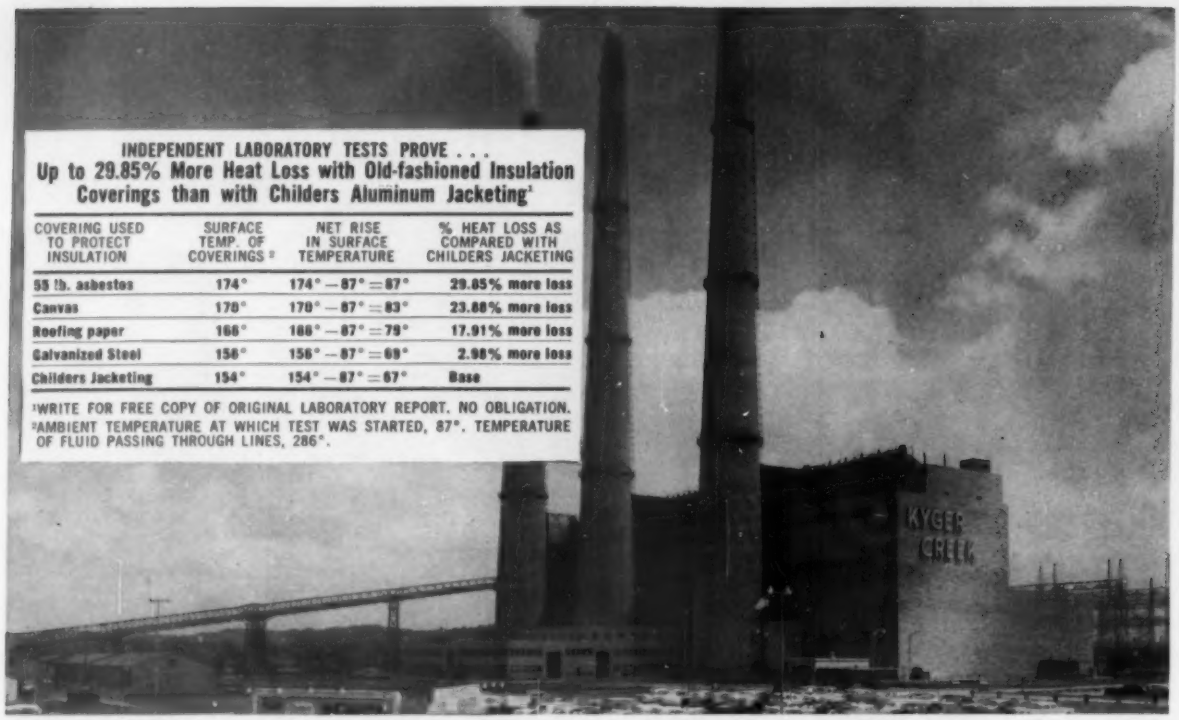


INDEPENDENT LABORATORY TESTS PROVE . . .
Up to 29.85% More Heat Loss with Old-fashioned Insulation Coverings than with Childers Aluminum Jacketing[1]

COVERING USED TO PROTECT INSULATION	SURFACE TEMP. OF COVERINGS[2]	NET RISE IN SURFACE TEMPERATURE	% HEAT LOSS AS COMPARED WITH CHILDERS JACKETING
85 lb. asbestos	174°	174° − 87° = 87°	29.85% more loss
Canvas	170°	170° − 87° = 83°	23.88% more loss
Roofing paper	166°	166° − 87° = 79°	17.91% more loss
Galvanized Steel	156°	156° − 87° = 69°	2.98% more loss
Childers Jacketing	154°	154° − 87° = 67°	Base

[1]WRITE FOR FREE COPY OF ORIGINAL LABORATORY REPORT. NO OBLIGATION.
[2]AMBIENT TEMPERATURE AT WHICH TEST WAS STARTED, 87°. TEMPERATURE OF FLUID PASSING THROUGH LINES, 286°.

More than 500,000 square feet of maintenance-free Childers Aluminum Jacketing protect the insulated lines in this modern Kyger Creek Plant of the Ohio Valley Electric Corporation which was rated first in overall thermal efficiency in recent annual ratings of major power plants by the Federal Power Commission.

Power Plants Run 15° to 20° Cooler With Childers Aluminum Jacketing Installed

- **Reduces heat loss by radiation**
- **Lose fewer BTU's per KWH**

. . . yet cost is less than canvas-and-paint

Certified test results prove Childers Jacketing saves money for power plants by increasing the efficiency of any insulation. Its low factor of emissivity keeps heat inside . . . fewer BTU's are lost per KWH.

First cost is less for maintenance-free Childer's Jacketing—*actually less than canvas-and-paint.* You protect your insulation investment at lower cost and get the bonus of a better looking plant and easier housekeeping.

Compare . . . Figure YOUR Savings:

Material & Labor Cost per Sq. Ft.	
Canvas-and-Paint	
8 oz. canvas covering	$ .167
One coat of paint	.044
TOTAL	$ .211
CHILDERS .006" Aluminum Jacketing	.184
Your SAVING per sq. ft.	$ .027

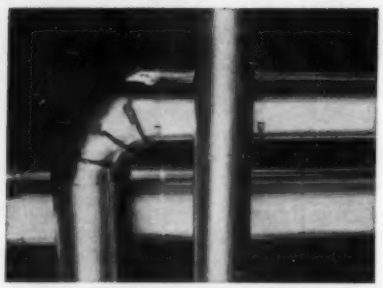
Power engineers at America's leading power plants prefer Childers Jacketing. Exclusive features make installation easy, performance superior —yet, first cost is less than canvas-and-paint.

Engineering Representatives in 27 cities provide technical information and assistance on protection of insulated lines, elbows, towers, vessels, tanks. Only Childers has this nationwide service organization.

For a free copy of the original independent laboratory heat loss report and sample of Childers Jacketing, write to:

Childers Manufacturing Co.
P. O. Box 7467
Dept. PE-4
Houston 8, Texas

In Canada, write direct to Peerless Mfg. Co., Sub-Post Office 28, Calgary, Alberta.



CHILDERS FEATURES CUT COSTS:

1. NEW CHILDERS ALUMINUM ELL-JACS solve costly problem of protecting insulated elbows. Give you permanent protection. Precision-formed for both 90° and 45° long-radius ells.

2. EXCLUSIVE LAP-SEAL, available at no extra cost, is a series of 8 ribs rolled into the underlapping edge of jacketing, providing automatic measure of the 2" circumferential lap.

3. FACTORY-ATTACHED MOISTURE BARRIER protects the underside of the aluminum from possible attack by alkaline solutions present in many insulating materials, eliminates the need of applying a separate moisture barrier.

4. CROSS-CRIMP increases strength of jacketing, cuts material cost.

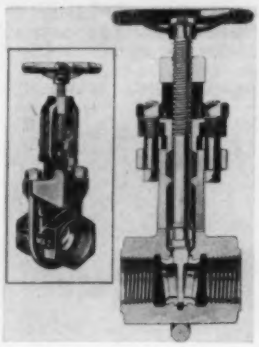
ONLY CHILDERS MAKES AVAILABLE TO YOU COMPLETE SPECIFICATIONS AND ENGINEERING DATA ON ALUMINUM JACKETING IN THESE CATALOGS: SWEET'S INDUSTRIAL CONSTRUCTION FILE PP. 10B/CH; CHEMICAL ENGINEERING CATALOG PP. 1011-1014; REFINERY CATALOG PP. 317-320.

For more data circle 551 on Post Card

renders it impervious to acids with which it comes in contact, company points out; it withstands high pressures and temperatures to 700 F and is impervious to water, steam, acids or oils. Lonsor costs less than $3.50 a pound. Newage Industries, Inc.

14—GATE VALVES designed for corrosive applications

Causul metal gate valves in the improved Fig. 1910 series come in sizes from ½ to 8 in., with screwed or flanged ends, "King-Clip" or bolted bonnet type, with stainless steel or Monel trim, and are rated from 175 to 225 lb, w.o.g. Principal change announced is the full-



way design with full seat openings that maintain pressure and flow at maximum for any specific size. Bodies, bonnets and glands are made of Causul metal, an austenitic iron containing about 20 per cent nickel and substantial percentage of copper, chromium and molybdenum. These valves are claimed to handle sulphuric acid over a range of concentrations, alkalis and other corrosive fluids. Outside stem and yoke construction is used in both designs. This places the stem threads out of the solution the valve carries. Discs are solid Monel or stainless. Lunkenheimer Co.

15—ELECTRICAL INSULATION with soldering

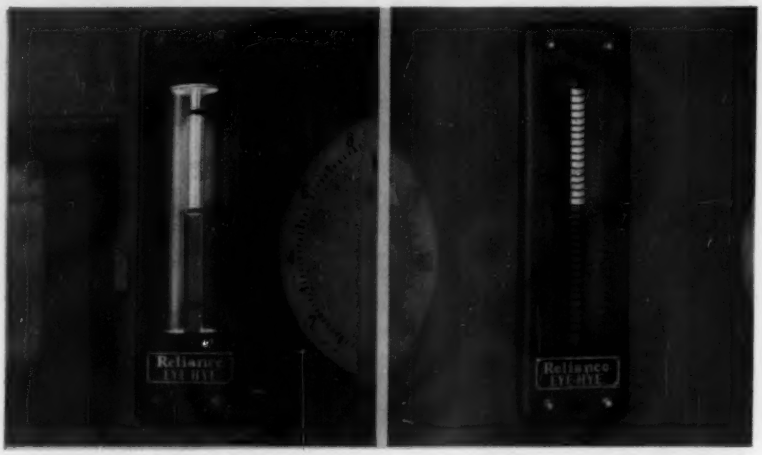
Hyrad-FR is claimed to retain the excellent electrical properties of polyethylene, but have greatly improved heat stability and cold flow resistance — plus flame retardance. As explained by manufacturer, electron streams bombarding an insulated wire cause a cross-linking of the polyethylene molecules; this changes the plastic from a two-dimensional molecule, which is a thermally sensitive thermoplastic, to a three-dimensional thermally stable thermosetting configuration. An outstanding feature announced is ability to withstand a soldering operation. Sequoia Wire and Cable Co.

16—TEST SET determines dissolved oxygen in feedwater

Testing of low concentrations of dissolved oxygen in boiler feedwater can be done by inexperienced persons — with accuracy within 2 ppb of oxygen — with this colorimeter test unit, it is announced. Six permanent color standards in sealed tubes represent, 0, 5, 10, 15, 25 and 50 ppb oxygen. Differences in color shades made estimations accurate

Safe, sure check on boiler water levels with wide-vision EYE-HYE

The remote gage with liquid indication



EYE-HYE for pressures up to 600 psi

EYE-HYE for pressures up to 3000 psi

Put your boiler water level supervision on a plane with other power plant control facilities — read levels at your control station with Reliance EYE-HYE.

The dependable accuracy of this popular remote reading indicator eliminates "boiler-climbing"; its bright green liquid-column image stands out — mistake-proof. And EYE-HYE's improved design provides visibility over a wide arc — lower pressure models up to 90°; new higher pressure models, to 180°.

Simple manometric design, with no mechanical parts and no adjustments on location. Available with economical special attachment to actuate supplementary alarms . . . Write for catalog information on EYE-HYE for *your* boiler pressure.

The UNITEMP, complete temperature equalizing unit furnished with each EYE-HYE

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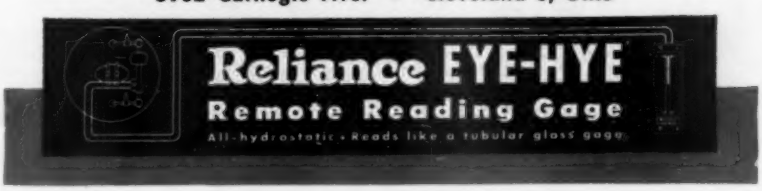
The Reliance Gauge Column Company

5902 Carnegie Ave. • Cleveland 3, Ohio



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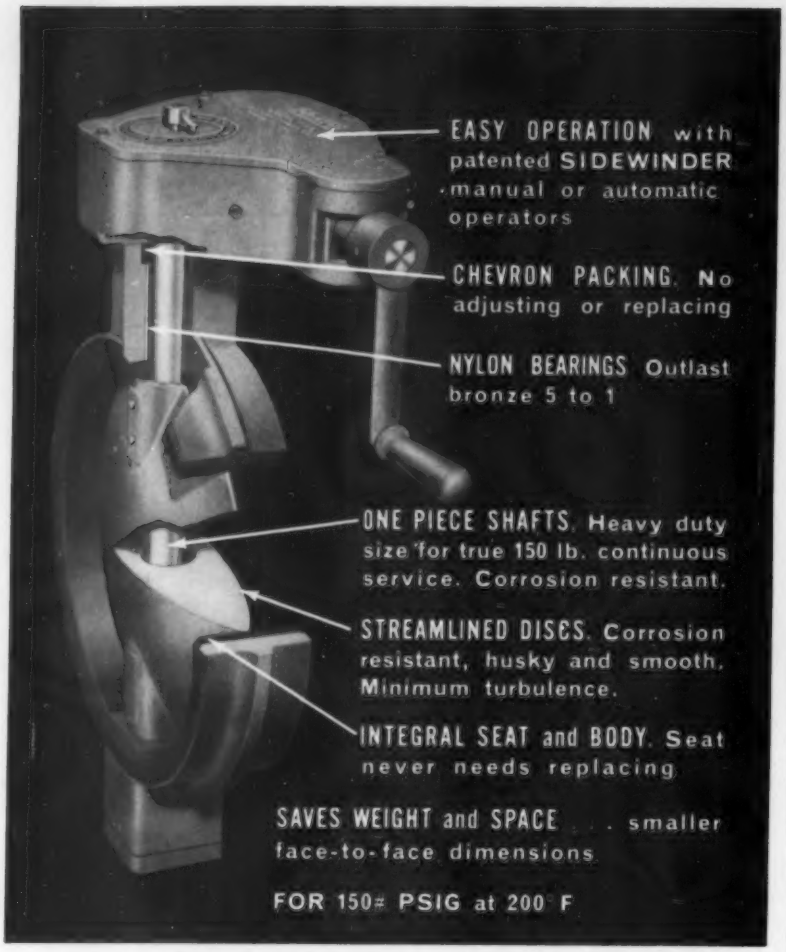
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CHEVRON PACKING. No adjusting or replacing
NYLON BEARINGS Outlast bronze 5 to 1
ONE PIECE SHAFTS. Heavy duty size for true 150 lb. continuous service. Corrosion resistant.
STREAMLINED DISCS. Corrosion resistant, husky and smooth. Minimum turbulence.
INTEGRAL SEAT and BODY. Seat never needs replacing
SAVES WEIGHT and SPACE . . . smaller face-to-face dimensions
FOR 150# PSIG at 200° F

7 important features help solve valving problems

The MONOFLANGE MARK II is built for tight shut-off at 150 lbs., is ideal for throttling service, and versatile in application.

This is a Henry Pratt *Market Oriented* product . . . ALL NEW . . . built to answer industry's specific needs for this type of valve.

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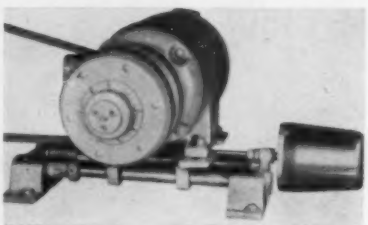
to nearest 2 ppb between zero and 15 parts, it is explained. Standards vary from yellow to a reddish purple. To analyze for dissolved oxygen, you draw water into the sampling tube placed in a container. Leuco solution, a mixture of indigo carmine-dextrose dye and a potassium hydroxide solution, is added to the tube under water. The tube is then removed from container and color compared to standards. The kit contains all reagents and equipment for testing, including 12 capsules — about 900 tests can be performed with contents. Bulletin HSP-916 gives details. Hagan Chemicals & Controls, Inc.

17—ACTUATOR for the sliding motor base drives

The SM-18 Shaftrol Actuator is designed to provide low-cost control for variable speed drives, valves, pumps, reactors and machine tools. It is available with



a built-in potentiometer, gear connected to the output shaft through a wide choice of ratios, so that from 1/6 to 40 shaft revolutions corresponds to full scale control. The potentiometer provides remote indication of position on a dial or meter, or serves in automatic control circuits. Ratings to 3/4 hp are available in single- and three-phase styles with 500-w units offered in two-phase, servo types. The Jordan Co., Inc.

18—PUMP-TANK COMBO for general chemical feeding

This compact and low cost pump-tank combination incorporates Proportioneers

Model 1106 Adjust-O-Feeder and is designed for minimum space. The 55-gal steel support drum contains the molded polyethylene tank for the chemicals and is mounted atop a three-legged angle iron frame. The pump, with its strainer, fittings and hoses, is mounted on cross members of the frame. The entire unit stands only 53 in. high. Tank, fittings and tubing are of corrosion-resistant materials. Pumping capacity is up to 50 gph for discharge pressures up to 1100 lb. B-I-F Industries, Inc.

19—BELLOWS-TYPE SEAL, all metal, for severe conditions

Series AMB is described as a reliable, economical, all-metal "bellows-type" mechanical shaft seal designed for use in severe environments of corrosion and

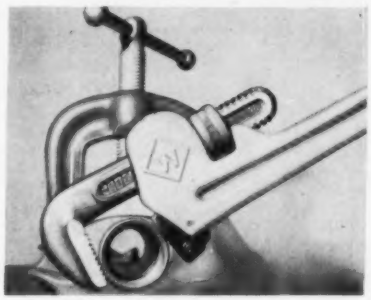
critical temperatures and pressures. Company says it will operate at pressures to 1000 psi, speeds to 36,000 rpm, temperatures from −400 to 1000 F. The seal is claimed to resist most corrosive bases and acids, both liquids and gases, and provide leakproof sealing of hazardous fluids, and to achieve balanced hydraulic loading and withstand temperature cycling without impairing performance. Series AMB comes in sizes to 7-in. shaft diameter. Turbocraft, Inc.

20—JOINT COMPOUND, SEAL withstands both heat, cold

Cualaid is described as an improved, thixotropic joint compound and sealant which won't melt or flow no matter how it gets — yet remains smooth and workable down to −100 F. Manufacturer says Cualaid won't liquefy when directly exposed to a flame, and that it seals moisture out of a joint, protecting the connection under all operating conditions. Cualaid is claimed inert to natural rubber and leather goods, non-staining, non-poisonous, and non-irritating. Electrical tests are reported to indicate improved performance on both aluminum-to-aluminum and aluminum-to-copper. Penn-Union Electric Corp.

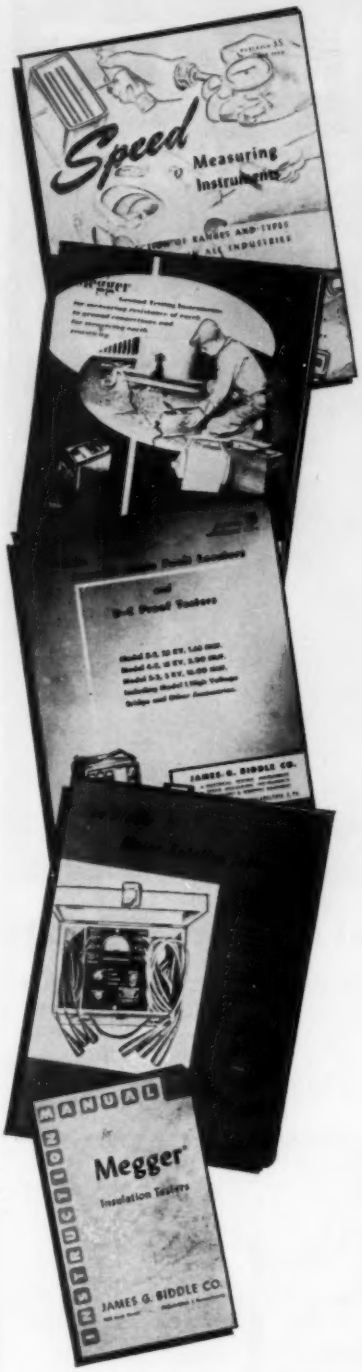
21—PIPE WRENCH is self-adjusting, 10 to 24-in. sizes

This wrench features a sliding lower jaw designed to automatically tighten its grip as more force is applied. It won't slip, company states, yet instantly releases on the backstroke for easy removal even in close quarters. According to manufacturer, the sliding jaw automatically takes up the slight variation of adjustment resulting from rough handling, and this jaw in its extended position gives increased leverage and a more positive grip on irregular shapes. Wheeler Mfg. Corp.



22—OIL SEAL heavy duty, for use with gear units

This taconite oil seal is designed to prevent entry of taconite or other abrasive dusts and particles into the gear housing. A feature is an alemite grease fitting which remains stationary even when gear shaft is turning. Thus, the grease in the seal can be replaced without stopping the machine. Grease is pumped through fitting and first enters cavity in the gear housing end plate in front of a dual-lip friction seal. Grease is then forced outward toward a rotating steel seal. Contaminated grease flows from the cavity through a 1/32-in. clearance between end plate and rotating



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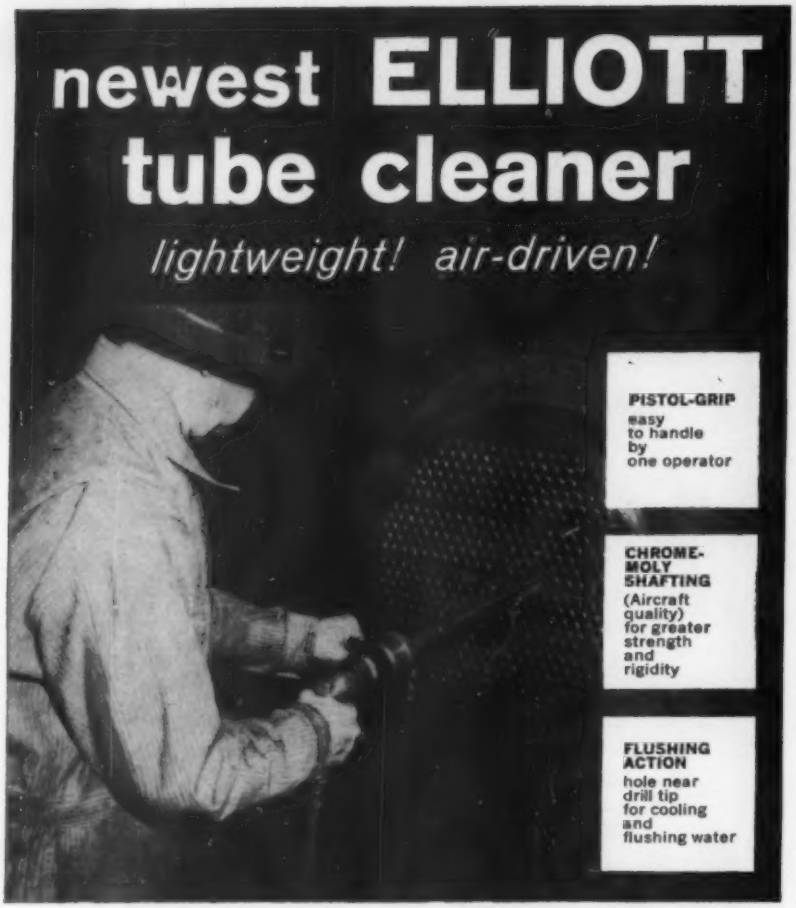
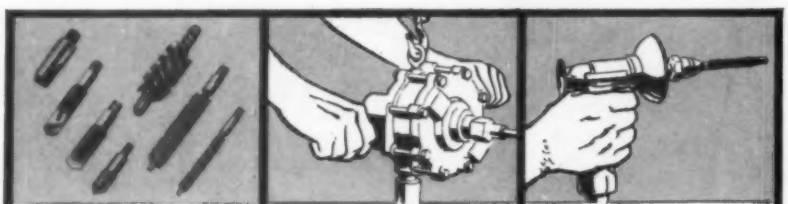
newest ELLIOTT tube cleaner

lightweight! air-driven!



for condenser and heat exchanger tubes

Lightweight. Powerful. Air-driven. Trigger-action control with speed governor to prevent shaft-whip. High-speed motor reduced through planetary gears to 1500 rpm. Integral water-feeding attachment with finger-action valve which controls flow of cooling water into hollow shaft and drill or brush. Built-in oil reservoir. Send for tube cleaner bulletin Y-48.



DRILLS AND BRUSHES FOR VARIED NEEDS
Brushes for light deposits. Four types of drills clean light, hard-heavy, hard-light, and gummy deposits.

SUSPENSION TYPE
Air, steam or electric heavy-duty motor, for removing hard, heavy deposits. Ball bearings absorb thrust in either direction.

ELLIOTT JIFFY GUN
For extra-fast cleaning of light deposits in tubes ½ in. to 1¼ in. Air or water pressure shoots nylon brushes or rubber plugs through tubes.

ELLIOTT Company
Lagonda Plant—Springfield, Ohio

Y8-4

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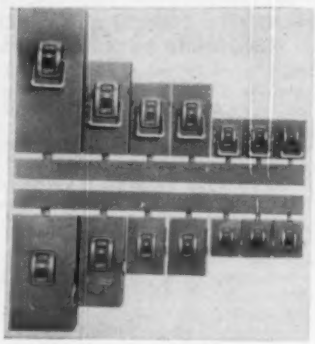
seal. Maintenance personnel can inspect this clearance to determine if there is sufficient grease in seal. The Westinghouse Electric Corp.

23—SAFETY SWITCH for close-ganged installations

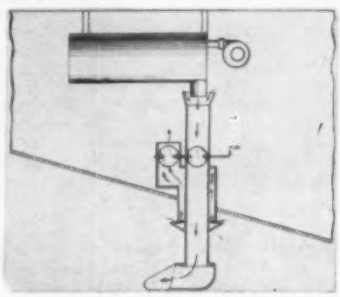
Bottom hinging and front operation on these safety switches are designed to permit significant economies in space where only limited mounting space is



available. Because there is no projecting mechanism or hardware on the sides of the switches, the devices may be ganged one against the other. The bottom hinged cover detaches by removing a screw, simplifying and speeding up installation, company points out. Bulletin CPD-74 describes 30- through 600-amp light and heavy-duty switches. General Electric Co.

24—FLUE SYSTEM provides for adequate air supply

In the improved Compensating Flue System, twin dampers control flue and air inlet openings at the same time and by the same operator. Dampers may be controlled by limit switches for open position start and closed position for shutdown of combustion equipment. The system was developed to meet requirements of blast-fired gas furnaces, boilers



or other heating devices in closed rooms for a minimum of 10 cu ft of air for each 1000 Btu of fuel burned. With this flue system, air required for combustion is replaced by new air entering the sleeve opening through the roof. Design of the fresh-air sleeve is such that it not only insulates the hot exhaust flue from contact with the roof, but provides partial preheat of fresh air coming into the boiler or furnace room.

The system is self-balancing, since only as much air comes into the space

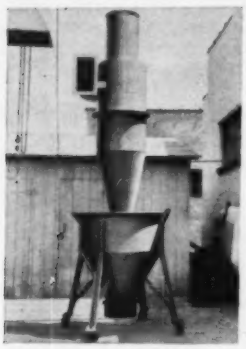
as is exhausted up the stack with the flue products. The twin dampers are linked on the same control, permitting simultaneous opening and closing of both flue and air outlet. An optional limit switch may be installed on damper lever. Eclipse Fuel Engineering Co.

25—TWO-COLOR GAGE gives better water level indication

Improved construction of the Diamond MP 3000 Multi-Port Bi-Color Gage is designed to avoid possible confusion of colors in the steam space by providing sharper red (steam) and green (water) colors. In this gage, condensate flows down through a bypass channel instead of through the observation channel — where condensate can cause streaks of green in the normal red of the steam space. The gage is suitable for pressures to 3000 psig and comes in standard lengths of 15-in. vision (seven ports) and 21-in. vision (nine ports). Diamond Power Specialty Corp.

26—DUST COLLECTOR of improved involute design

The improved, involute design of the Type IC Cyclo-trell is reported to permit high efficiency collection of abrasive or heavy dust loadings as found in steel sintering, petroleum refining, chemical



and cement plants. According to manufacturer, virtually any size job can be handled through the variety of arrangements possible with these mechanical dust collectors. Catalyst dust suspended in reactor effluent and regenerator flue gases from the fluid catalytic cracking process may be collected, it is pointed out, and followed by a 24-in. Cyclo-trell with steel mesh liner (Type C24L) and an electrostatic precipitator, the combined units remove even finest residual catalyst particles. To handle abrasive dusts, the involute type collectors can be fitted with steel mesh liners incorporated with castable cements. Bulletin 300 gives data. Research-Cottrell, Inc.

27—ADDITIVE for use with diesel oil and fuel oil

Used in the ratio of a gallon to 500 gal of conventional fuel, Fuel-X is claimed to improve combustion, reduce hard carbon deposit, eliminate condensation, inhibit corrosion and reduce mechanical labor and parts in servicing fuel pumps, valves, filters and injectors. Its use is also said to reduce smoke and air pollution. The Fuel-X Corp.

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Superior's Tangent Tube Wall Construction

ENDS CASING CORROSION

The drawing at the right shows the construction of the water wall of a Type D Superior Packaged Boiler.

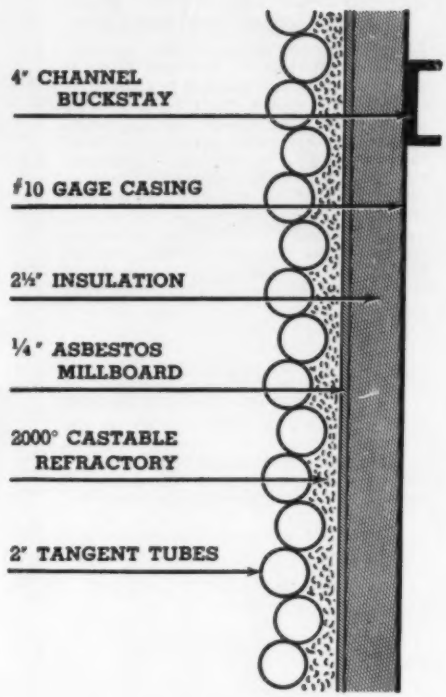
Note that the tubes are in contact with one another along the entire wall. This staggered tangent tube feature, plus a backing of 2000° castable refractory, ¼" asbestos millboard, and 2½" insulation protects the casing from damage due to gas penetration from the positive pressure furnace and its resulting condensation on the inside of the casing.

So effective is the cooling surface of these tangent tubes and their backing, that the boiler may be operated without danger to the refractory even with a tube plugged and inoperative.

No finned or bare tube water wall can provide a higher ratio of effective heating surface.

Another important design feature of Type D boilers which contributes to longer boiler life is the inspection openings both top and bottom along the entire boiler tube bank. These inspection openings, shown in the illustration below, eliminate the necessity of burning out the casing in order to inspect rolled tube joints.

Tube holes are serrated to insure protection against caustic embrittlement.



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For installations requiring capacities from 11,000 to 61,000 lbs. of steam per hr. or more, Type D Superior Packaged Boilers provide the ideal answer. True packages, thoroughly engineered, Type D boilers utilize the proven D type tube arrangement. They are built and tested as packages with their own burner equipment, mechanical draft fan, and controls to suit the requirements of the purchaser.

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PUMPS, COMPRESSORS

201 **Flow Control** — Twelve-pp Catalog 801 describes four basic models of precision proportioning pumps for uses requiring accurate and positive proportioning of flow in range of 0 to 730 gph. Materials of construction, capacities and pressures are shown for each. Diaphragm valves are discussed and their features noted. Hills-McCanna Co.

202 **Controlled Volume Pumps** — Bulletin 1257 describes company's mini-Pumps for metering chemicals in minute volumes against pressures. Contains specifications on laboratory, industrial and chromatographic designs. Milton Roy Co.

203 **Gear Pumps** — Bulletin G-1 describes gear pumps designed for a variety of difficult pumping applications. Cutaway view illustrates construction and operation details and tables give dimensional data. Schutte and Koerting Co.

204 **For Abusive Pumping Jobs** — Catalog 5206 covers centrifugal pumps for wide industrial use and especially adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horizontal shaft, single-stage side suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps with standard, overhead and quill bearings for wet pit applications. Nagle Pumps.

205 **Air Compressors** — Performance advantages of company's heavy duty V-vertical air compressor featuring aluminum maintenance and compactness are detailed in 24-pp Bulletin A-62. The V-vertical construction details are shown on cutaway and components described, as well as force feed lubrication and mounting types. Specifications given. Joy Mfg. Co.

FANS, BLOWERS

206 **Mechanical Draft Fans** — Bulletin FD-905, 28 pp, describes a mechanical draft and other heavy-duty fans for a variety of industrial applications. Includes basic data for proper fan selection, performance tables, design sketches, component and installation photos of many types from kiln fans to cyclone compressors. Buffalo Forge Co.

207 **Air Engineering** — Bulletin E-57 is a 24-pp air engineering data file covering engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handling requirements, entrance and elbow losses are provided. Aerovent Fan Co., Inc.

208 **Rotating Blower** — Features and advantages of company's fixed posi-

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tion rotating blower for cleaning tube blanks in boilers, superheaters, reheaters, economisers, heat exchangers, and other equipment, are detailed in 8-pp Bulletin 1137A. Typical applications are shown. Diamond Power Specialty Corp.

BOILERS, GENERATORS

209 Fire Tube Boilers — This 12-pp catalog describes Superior Compact packaged boilers in capacities from 20 to 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features. Gives dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

210 Package Boilers — This 12-pp booklet on package steam generators describes the formulas behind all package steam generators, and illustrates how installation of a package steam generator can raise steam capacity in an existing boiler room. Cyclotherm Div., National-U. S. Radiator Corp.

211 Hot Water Boilers — This 20-pp Brochure HCC-2 describes and illustrates design, construction, advantages and economics of the C-E La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and process uses. Combustion Engineering, Inc.

212 Packaged Steam Generator — Advantages of company's baffleless, pressurized two-drum water tube packaged units are detailed in 12-pp Catalog SB-59. Features of the completely integrated generating plant, which requires no field piping, wiring, brickwork or special foundation, are shown on cutaway illustration. Erie City Iron Works.

213 Integral-Furnace Unit — Bulletin G-94 describes the Type PFI integral-furnace boiler, a pressurized-furnace oil- and gas-fired steam generator for power, process or heating loads requiring steam capacities to 400,000 lb-hr at pressures to 1150 psi and temperatures to 900 F. Includes information on membrane wall. The Babcock & Wilcox Co.

214 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are finished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

HEAT EXCHANGERS

215 Heat Exchangers — Bulletin 132 contains detailed information on company's self-contained heat exchanger featuring sectional design. Cutaway diagram shows heat exchanger functions. Niagara Blower Co.

216 Heat Exchanger — Featured in this 12-pp bulletin is the Fin-Pak, a compact heat exchanger designed for a wide variety of fuel burning and process equipment. Structural details and operating principles are illustrated and typical installations shown. The Air Preheater Corp.

WATER CONDITIONING

217 pH and Chlorine Control — The 14th, 1959 edition of company's hand-

OCTOBER, 1959

NOTE: Card void after January 31, 1960

POWER ENGINEERING

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Helpful Bulletins

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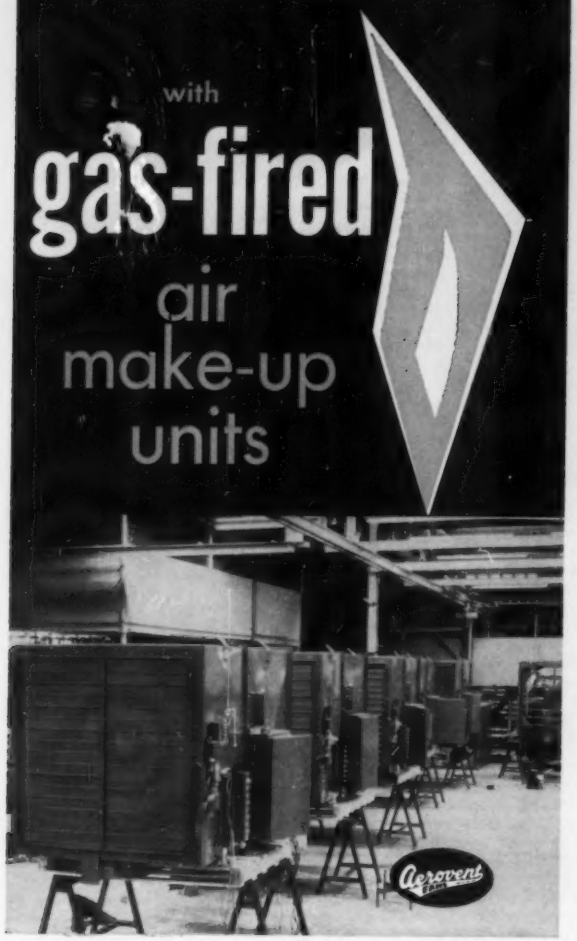

Pictured above is a portion of the final assembly line at Aerovent showing 8 units slated for delivery to a large Midwestern automobile accessory manufacturing plant. Designed to supply ample quantities of clean, pre-heated or cool, outside air to replace air exhausted by ventilating systems, the Aerovent Gas-Fired Air Make-Up Unit keeps air fresh; eliminates drafts and negative pressures. Safe, dependable operation and automatic, semi-automatic or manual control with natural, mixed, manufactured or propane gas.

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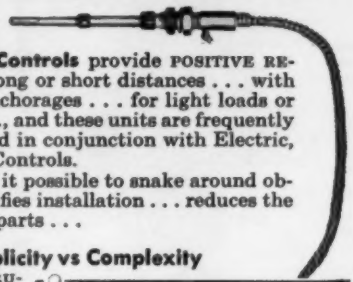

Tru-Lay Push-Pull Controls provide POSITIVE REMOTE-ACTION over long or short distances . . . with fixed or movable anchorages . . . for light loads or loads up to 1,000 lbs., and these units are frequently and successfully used in conjunction with Electric, Hydraulic and Air Controls.

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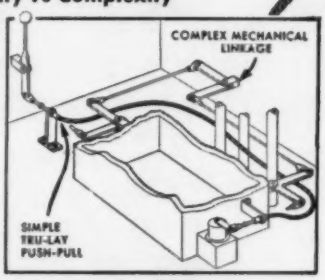
Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Positive Remote-Action and Flexibility, together with Precision and Long Life, explain why TRU-LAY PUSH-PULLS serve designers and users equally well in improving machine operations, whether the application is on such severe service jobs as Bulldozers, Power Shovels and Steel Mill Machinery, or on such light duty work as Photographic Equipment, X-Ray or Business Machines.

Immunity to Vibration makes these TRU-LAY PUSH-PULLS ideal as Remote Controls on shakers and other vibratory products.

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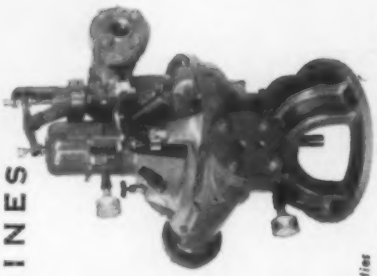

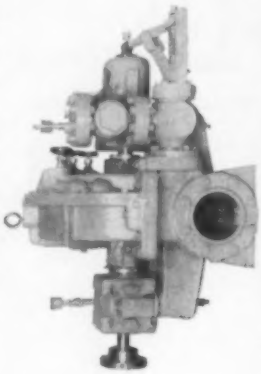

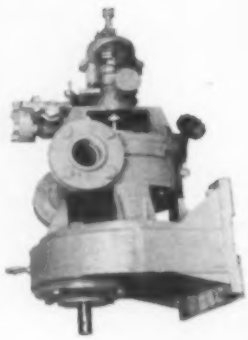

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book, "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica, nitrate, hardness. Available to qualified power engineers, please state your job title. W. A. Taylor Co.

219 Coagulant Aids — Featured in this product bulletin is a line of coagulant aids designed to improve floc formation in clarifying and softening water. Advantages are detailed and typical applications described. Calgon Co., Div., Hagan Chemicals & Controls, Inc.

220 Feedwater Treatment — Process Bulletin B1, "Treatment of Boiler Feedwater by Direct, or Internal Method," discusses advantages of direct treatment, as a complete treating program or as a supplement to external systems. Explains why direct treatment is convenient, economical. Nalco Chemical Co.

221 Deaerating Heaters — Twelve-pp Bulletin WC-106A on tray type deaerating heaters covers principles of deaeration, tray heater operation, standard heater design and applications, accessory equipment, and design and fabrication of tray utility heaters. A section on design features discusses load variations, installation, metallurgy and construction of trays. Graver Water Conditioning Co.

COAL AND ASH HANDLING

222 Coal Crusher — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

223 Coal Sample Crusher — How you can save on your fuel bill and power cost with company's coal sample crusher is explained in Bulletin CS2. Illustrated with photos and dimensional diagrams, discusses operation and features. Gruendler Crusher & Pulverizer Co.

225 Hydraulic Shakeout — Bulletin 658 describes and illustrates the Carquake, hydraulically powered car shakeout designed for maximum car shaking with minimum noise. Rail- and stationary-mounted types are shown. Six advantages detailed. Stephens-Adamson Mfg. Co.

TUBING AND ACCESSORIES

226 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and plates for condensers and heat exchangers. Field of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. The American Brass Co.

227 Electric Tube Cleaners — Bulletin E107 describes advantages and applications of company's electric tube cleaners for boilers, condensers, evaporators, and

THESE NEW IDEAS HAVE COME FROM

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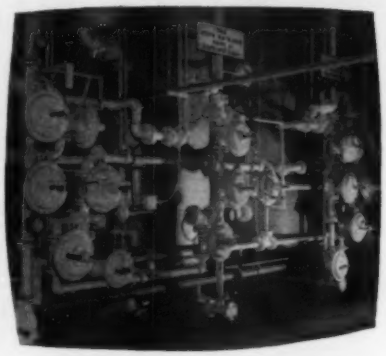
MODERN EQUIPMENT FOR ionXchange



Illinois Water Treatment Co. was incorporated over 20 years ago to use the newly-discovered resins in the development of ionXchangers.

1942 By this time, IWT had already built more than 50 successful multi-bed ionXchangers (some of which are still in use today).

1943 IWT brought "automation" to ionXchange with the introduction of automatic ionXchangers, some of which were very large. (Some of *these* are still operating today, also.)

1947 This was the year when IWT brought out the first large (400 gpm) ionXchanger for silica removal.

1949 IWT built the first commercial *Mixed Bed* ionXchanger.
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1954 A huge 5,000 gpm fully-automatic mixed-bed ionXchanger was designed and built by IWT to remove silica from make-up water for high-pressure boilers. This plant has now de-ionized over SIXTY BILLION pounds of water.

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heat-exchangers. Tables are included giving complete specification details. Elliott Co. Roto Plant, Div. of Carrier Corp.

230 **Tube Cleaners** — Factors to be considered in choosing tube cleaning equipment are discussed in 32-pp Bulletin Y-48. Motors and component parts of cleaning equipment are described, and complete selection tables are included. Lagonda Div., Elliott Co.

FUEL BURNING EQUIPMENT

231 **Oil and Gas Burners** — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. The Engineer Co.

232 **Water-Cooled Stoker** — Design and operating advantages of the Vibragrate Stoker are outlined in this illustrated bulletin. A large cutaway view details component parts of the stoker and explains operating features. Other drawings show installations. American Engineering Co.

234 **For Low-Pressure Heating** — Guide Specifications GS-1, 59 pp, covers underfeed stoker applications to boilers best suited to commercial and industrial heating plants. Includes drawings of flexible layouts of the equipment, as well as specification criteria covering coal and ash handling, boilers, stokers and controls. Bituminous Coal Institute.

235 **Spreader Stoker** — Advantages and features of company's continuous ash discharge spreader stoker are detailed in 24-pp Bulletin 40. Illustrates and describes operation details, and includes diagrammatically illustrated specifications, schematic diagrams showing installations with various types of boilers, and photos of typical installations. Detroit Stoker Co.

REFRACTORIES

236 **Refractory Castable** — Bulletin R-40 describes the use of Kaocrete, company's refractory castable, in boiler ashpits. A discussion of the various methods of ash removal, along with the maintenance problems peculiar to each, is presented. Four installations detailed. Refractories Div., The Babcock & Wilcox Co.

237 **Refractory Mortar** — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant, refinery and metalworking equipment. Includes data on mortar preparation, placing procedures, curing; also information on use of Lumnite cement as a masonry mortar for laying brick. Universal Atlas Cement Div., United States Steel Corp.

MECHANICAL POWER TRANSMISSION

238 **Worm Gear Reducers** — Complete horsepower and torque data for company's worm gear units built on 2½ up to 4-in. centers are given in full-page tables in Bulletin 5018. Dimensions are diagrammed and tabulated in detail, and materials and design of interchangeable components are described. De Laval Steam Turbine Co.

239 **Self-Aligning Coupling** — Featured in illustrated Bulletin 273-M50

CRUSHING FACTS
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When You Figure Costs, The Best Results Come From American Coal Crushers

An independent survey of the performance of American Coal Crushers in 29 Mines and Power Plants showed these results:

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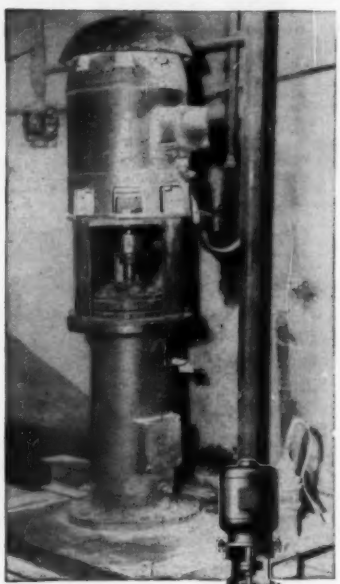

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are company's self-aligning forged steel couplings designed to transmit maximum torque indefinitely. A cutaway view showing component features and tables of ratings are included. Koppers Co., Inc.

240 Grommet V-Belts — Advantages of company's grommet V-belts are illustrated and described in this 8-pp bulletin. Belt features are fully described, and a section on how to figure a V-belt drive is included. Goodall Rubber Co.

VALVES, TRAPS, AND PIPING

241 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations, describing non-return (stop check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Edward Valves, Inc.

242 Forged Steel Valves — Featured in comprehensive Catalog F-10 is detailed information and engineering data on company's line of forged steel valves, fittings, flanges and unions. Includes photos and cutaway views illustrating component features, as well as tables giving dimensional data. An engineering design section with complete specifications and pressure-temperature tables is included. Henry Vogt Machine Co.

243 Reducing Valves — Direct-operated water pressure reducing valves are featured in illustrated Bulletin 1009. A cutaway view showing component features is included, as well as water capacity table, dimensional tables and diagrams. Spence Engineering Co., Inc.

244 Silent Check Valves — Described in Bulletin WH-654 are silent check valves featuring low frictional resistance. Tables list dimensional data and reasonable velocities for flow of water through pipe, fittings and valves. The Williams Gauge Co., Inc.

245 Safety, Relief Valves — Catalog 900-V contains 58 pp of comprehensive data on safety and relief valves for boilers, air receivers, hydraulic systems process equipment, and general pressure vessel protection. Includes glossary of terms, valve selector tables, selected technical data and condensed specifications. Cutaway views showing component parts are also included, as well as curves showing overpressure correction factors. J. E. Lonergan Co.

246 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

247 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. The Henry Pratt Co.

248 For Lightest Condensate Loads — Bulletin T1744 (58) describes company's No. 30 impulse steam trap for use where condensate must be handled in very small amounts. Lists advantages and applications, tells how trap works and

THE LONERGAN LINE

A. J. Schmidt
Chief Engineer

SIZING SAFETY VALVES

by A. J. Schmidt, Chief Engineer

Selection of a safety or relief valve should be made on the basis of the capacity requirements of the application, rather than on pipe size alone. Using pipe size as the sole basis may result in a valve with far greater capacity than required and the valve may chatter on the installation due to a "starved" condition. On the other hand, pipe size selection may provide a valve with too little capacity, which will not give adequate over-pressure protection.

It is much better to select a safety or relief valve for the actual capacity requirements of the system. This will reduce the initial cost and will keep operating costs down because proper operation and protection will be obtained.

Lonergan safety and relief valves provide additional cost advantages due to the high capacities provided for any given pipe size. Thus, you can specify the smallest possible valve to meet your capacity requirements. Lonergan V, W, 11-W, and 41-W series safety valves also provide all the advantages of top guided, nozzle valve construction and two-ring positive control as embodied in Lonergan Patent No. 2414794.

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gives capacities, dimensions, materials used, prices. Yarnall-Waring Co.

249 Steam Trap — Bulletin 257-B describes a steam trap which uses the kinetic energy of steam to close the valve. Features of trap are detailed, and dimensional data included. Sarco Co., Inc.

250 Steam Trap Book — Catalog K, 48 pp, is a manual of steam trapping practice. It includes a section giving physical data and prices on OF&T traps, cast semi-steel and forged steel inverted bucket steam traps, compound traps, ball float air and air relief traps. A handbook section explains how to calculate condensate load, and select traps for all classes of equipment; a maintenance section explains trap installation, testing, and maintenance. Armstrong Machine Works.

251 Flexible Ball Joint — Catalog 215-B, 20-pp, describes advantages of company's flexible ball joints for use in piping for power, process, heating, chemical, construction, or hydraulic service. Includes engineering specifications and data on the standard 300 lb series and the series 600. Screwed, flanged and welding end joints are listed, as are insulating joints and jacketed joints for handling asphalt and other liquids that solidify unless heated. Barco Mfg. Co.

252 Flexible Hose, Bellows — Sixteen-pp Catalog 187 describes applications and use of flexible metal hose and bellows. Engineering specifications and sizes, pressure ratings, materials and fitting attachments are included. Detailed drawings and pictures facilitate specifications of individual applications. Flexonics Corp.

INSULATION

254 Insulating Block — An insulation block fabricated from high temperature resisting minerals and effective up to 1700 F is described in 8-pp Bulletin 518-J. Provides thermal conductivity graph, size and thickness data, describes insulating-finishing cement. Baldwin-Ehret-Hill Co.

255 Pipe Insulation — Described in this company publication is the application of Gilsulate pipe insulation in the underground piping system of a large research center. Photos showing construction and installation details are included, as well as data on nature and uses of Gilsulate. Gilsulate Div., American Gilsonite Co.

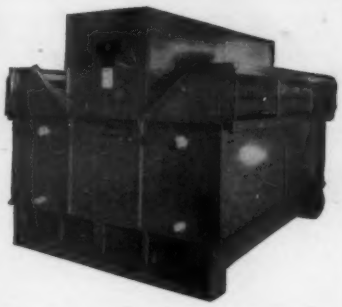
Postage-free cards for ordering catalogs are on page 123. You may also use the cards to order literature mentioned in the ads.

256 For Insulation Protection — Comprehensive data on mastics, coatings, adhesives, and flashing compounds for thermal insulation has been classified as to industry usage — power, process, cold storage, marine and commercial — in this ready-reference loose-leaf manual, about 208 pp. Detailed application information and product data is included, as well as photos, drawings and diagrams of applications. Benjamin Foster Co.

INSTRUMENTS, CONTROLS

258 Controls Data — Comprehensive data on all types of controls, including

NIAGARA SECTIONAL *Aero* HEAT EXCHANGER gives close temperature control, saves you LABOR, Power, Water



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diaphragm valves, pilot controllers, regulators, safety heads and tank vents are presented in this loose leaf notebook. Individual sections contain all pertinent information on each specific product, including descriptive details and engineering data, dimensions, specifications. Application and operation details are fully illustrated. Black, Sivalls & Bryson, Inc.

259 Ideas on Push-Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

260 Metering, Control Systems — Bulletin 500 describes purpose, design and operation of company's metering and control systems. Includes discussion and pneumatic and electric telemetering and pneumatic control, along with detailed literature references. Bailey Meter Co.

261 Testing Instruments — Bulletin 19–58, 16 pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos of each type. James G. Biddle Co.

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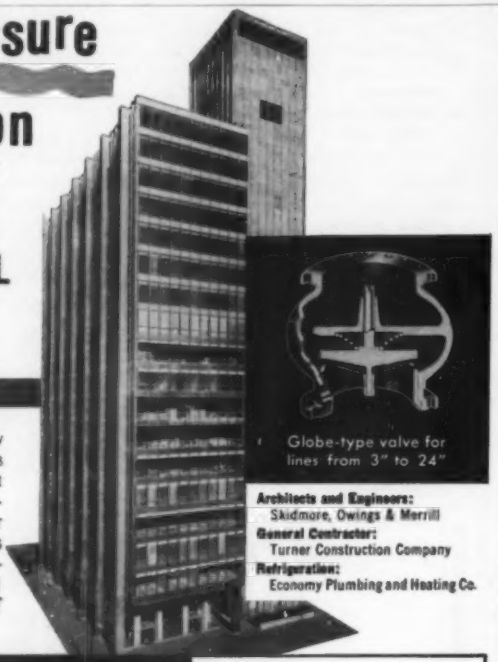

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262 Guide to Gages — Catalog 300-B, 112 pp, features Ashcroft, Dura-gauges, Maxisafe, pneumatic receiver, recording, quality, drawn case, chemical and special application gages. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in. Manning, Maxwell & Moore, Inc.

263 Draft Gages, Instruments — Bulletin 354-B is a condensed catalog giving a briefing on the company's line of stationary and portable draft gages, pitot tubes, air filter gages, gas analyzers, steam calorimeters. Ellison Draft Gage Co., Inc.

264 Automatic Data Systems — Described in Bulletin MSP-154 are electronic data handling systems for logging, monitoring, and integration of process information. Discusses basic design parameters, programming, switching, analog to digital conversion, linearization, calibration, digital ranging, print-out and off-normal alarms, remote switching, digital variable indication, integration, computation. Hagan Chemicals & Controls, Inc.

265 Instruments and Controls — Catalog 57-6 describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorders, temperature recorder, multipoint gages and others. Includes descriptive data. Republic Flow Meters Co.

266 Ion-Exchange Controls — Bulletin E-158 describes automatic control systems for ion-exchange equipment. Standards designed to assure proper performance of control units are detailed, and various elements in the control cabinets, as well as the power-operated units, are described. Specifications for electrical controls are also included. Illinois Water Treatment Co.

268 Pneumatic Controllers — Bulletin 1036 features a line of pneumatic controllers designed to automatically position a valve or other final control element to maintain fluid pressure or temperature. Specifications and other data included. Copes-Vulcan Div., Blaw-Knox Co.

269 Water Columns, Gages — Featured in Bulletin 516B are boiler water columns and gage equipment. Illustrates and describes water columns for all pressures, as well as remote reading gages, liquid level alarms, water gage illumination equipment, and electrode-type liquid level alarms. Reliance Gauge Column Co.

270 Gas Analyzers — Features and advantages of company's thermal conductivity gas analyzers are detailed in Bulletin 12686D. Components are illustrated and described, and tables giving cell output voltage and speed of response data are included. Industrial Instruments Engineering Corp.

271 Industrial pH Equipment — Eight-pp Bulletin 5400 gives detailed descriptions and specifications for industrial pH instruments, electrodes and accessories manufactured by the company. Brochure is profusely illustrated with photos and detailed drawings. Process Instruments Div., Beckman Instruments, Inc.

272 Oil Leak Detection — Eight-pp illustrated Bulletin 80, on the Paraprobe

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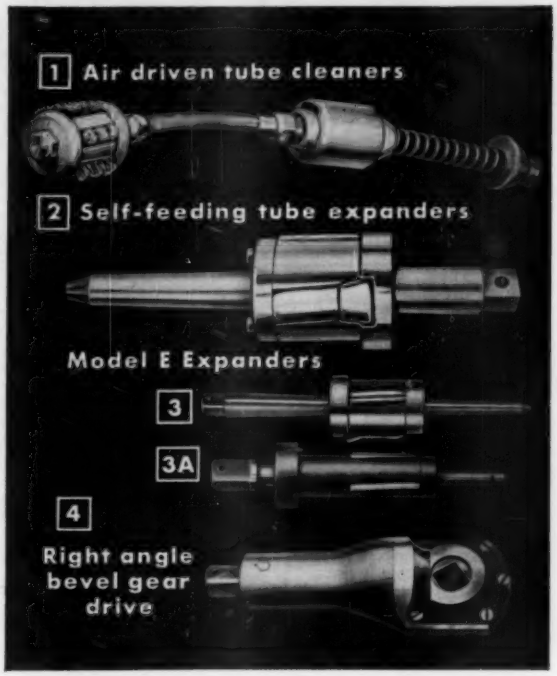

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oil leak detection system for steam-type fuel oil heaters gives a detailed explanation of the operation of the system. Provides installation diagrams, standard specifications, explains determination of condensate flow rate. Davis Engineering Corp.

TURBINES

273 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

274 Turbine Lubrication — Basic lubrication requirements for a wide range of turbines and gears are detailed in 28-pp Bulletin T-125-A. Sections cover care of the oiling system, turbine lubricants, lubricating oil recommendations, reduction gears and geared units. Oil circuit diagrams and other illustrations are included. Murray Iron Works Co.

275 Gas Turbine Engines — A variety of applications for company's gas turbine engines are described in this 8-pp bulletin. Among the applications described are ground support for commercial jets, emergency shipboard use, offshore oil industry, others. Solar Aircraft Co.

OTHER EQUIPMENT

276 Sheet and Plate Fabrication — Illustrated in 40-pp Bulletin F-3 are products of this manufacturer, and equipment used to produce special sheet steel and alloy parts. Shows control panels, switch gear housings, cubicles and other electrical enclosures, boiler air ducts, smoke breechings, tanks. The Kirk & Blum Mfg. Co.

277 Fuel Oil Additive — Described in this product sheet is an additive for boilers suffering from "tired" fuel oil. Advantages and characteristics are detailed. Kor Corp.

279 Story of Coal — This pocket-size booklet presents a complete picture of company's operations, traces the history of the coal industry and describes the many services and applications of coal. A colorful mural reproduced in the booklet pictures the part coal has played in civilization. Peabody Coal Co.

280 Organized Lubrication — Benefits of organized lubrication are extolled in this 24-pp bulletin. Cost control opportunities are detailed and the task of assigning responsibilities and delegating authority in an organized lubrication system discussed. Method of determining savings and setting up records to measure results is also covered. Texaco.

282 Handbook on Fuses — This 12-pp booklet contains practical information on how to get safe, dependable, trouble-free electrical protection. Shows what to do when fuses blow, how to determine cause of blows, what kind of fuse to use for various circuits. Contains short history of fuses and notes on construction of fuses. Bussmann Mfg. Co.

283 Dust Control Unit — Featured in Bulletin V-100 is a conditioner unit for dust control, designed to apply rapid, on-the-spot conditioning to dust material in all types of handling. Principles of operation are described in an accompanying engineering data bulletin, Bulletin V-101 The Johnson-March Corp.

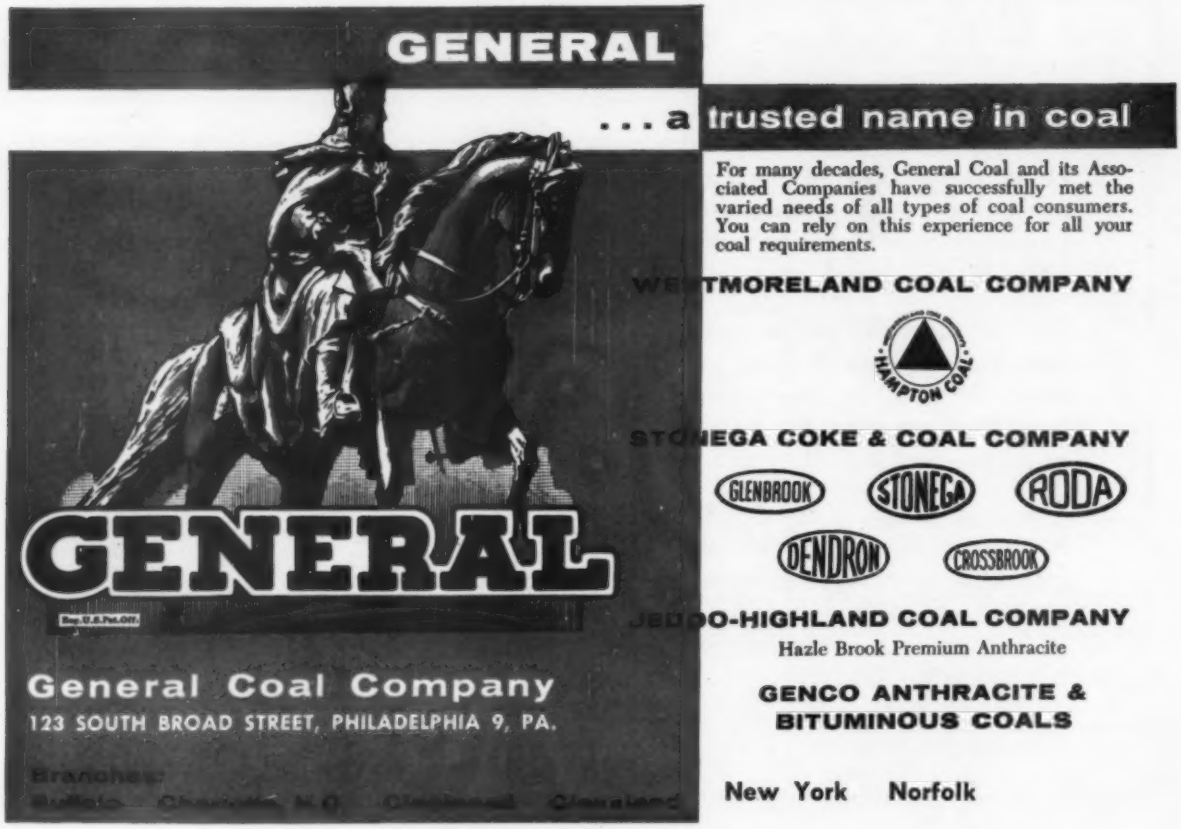
284 Safety Grating — Features and advantages of company's steel, aluminum and stainless steel safety grating are illustrated and described in 24-pp Catalog 5911. Describes types of loading and includes load charts. The Globe Co.

286 For Quiet Heating — Described in this bulletin is the HusHeater, designed to heat — without making a sound — water and liquids by introduction of steam into the liquid. Lists advantages of the HusHeater. Most common application is in filter boxes and hotwells. Sims Pump Valve Co. Inc.

287 Aluminum Jacketing — Bulletin 530a describes company's line of aluminum weather-proof jacketing for insulated lines, towers, vessels and tanks. Application procedures are pictured and suggested specifications offered. Childers Mfg. Co.

288 Equipment Selector Charts — Bulletin CE-50, 20 pp, contains selector charts on corrosion-resistant equipment for process industries. Tables cover general considerations in selection of material, physical properties, corrosion resistance. Describes rubber and plastic pipe, tubing and fitting; valves; pumps; lined tanks. Amerace Corp, American Hard Rubber Co.

289 Laboratory Supplies — This 12-pp price list announces latest prices for a wide range of laboratory supply items, including water analysis sets, conductivity equipment, colorimetric comparators, glassware and supplies, chemical reagents, and company's photometer with replacement accessories. Betz Laboratories, Inc.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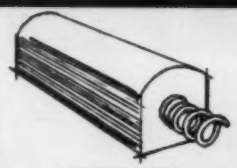		
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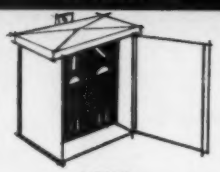	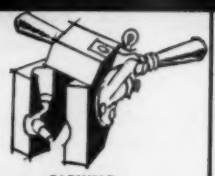	
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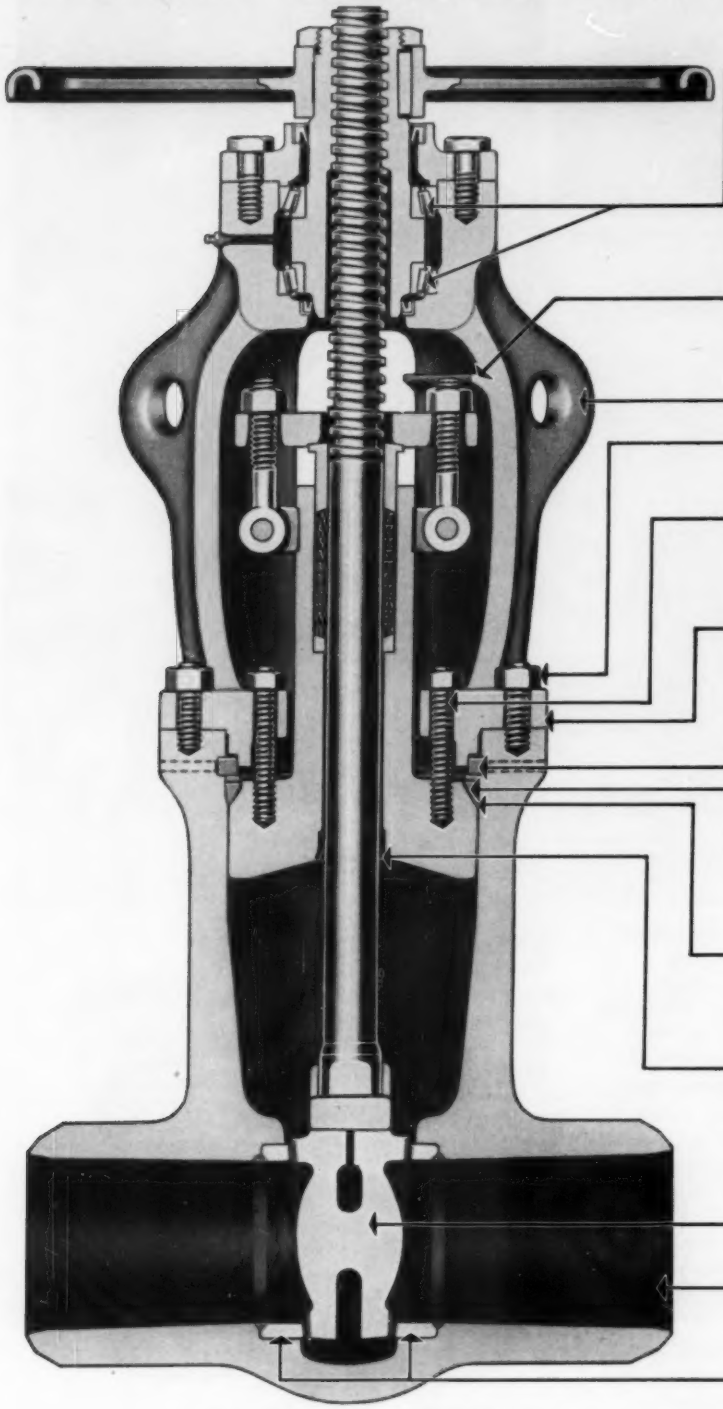

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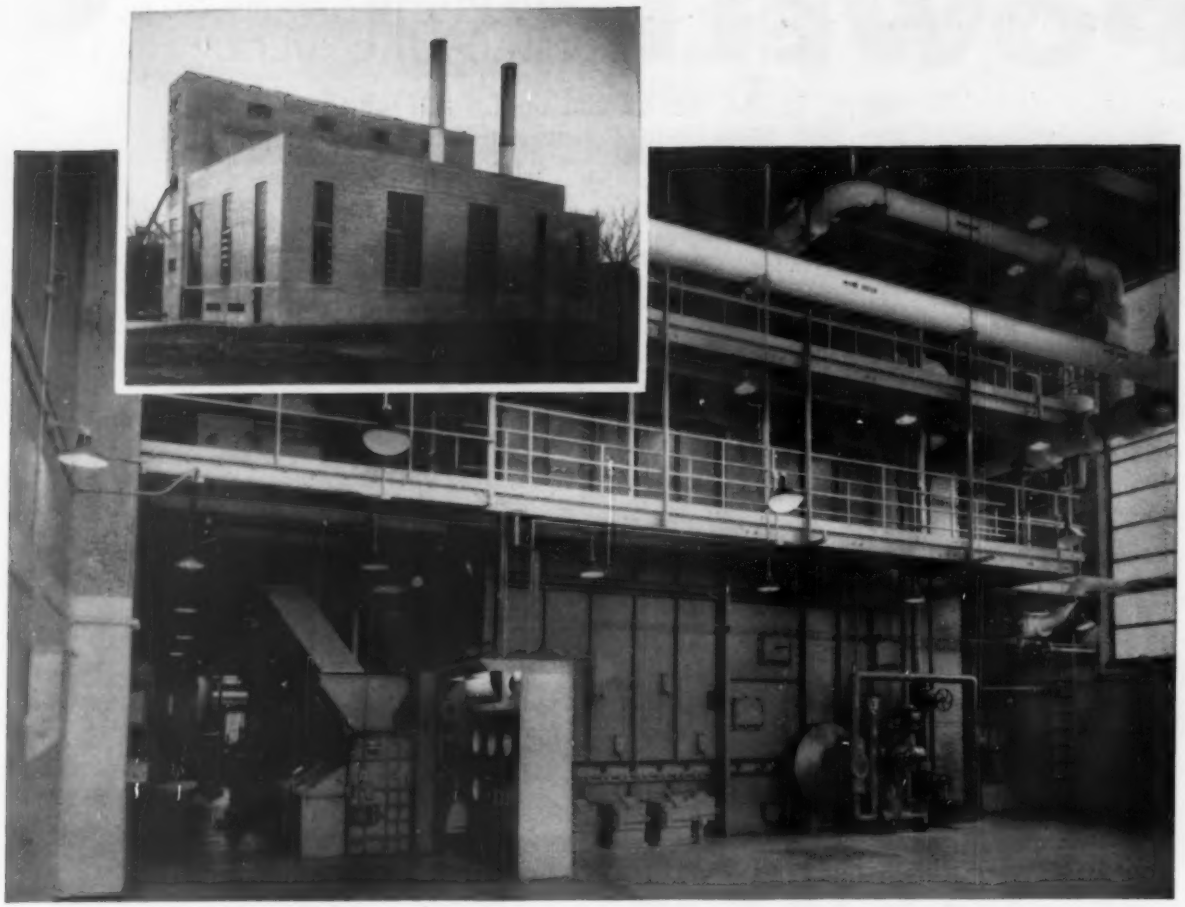

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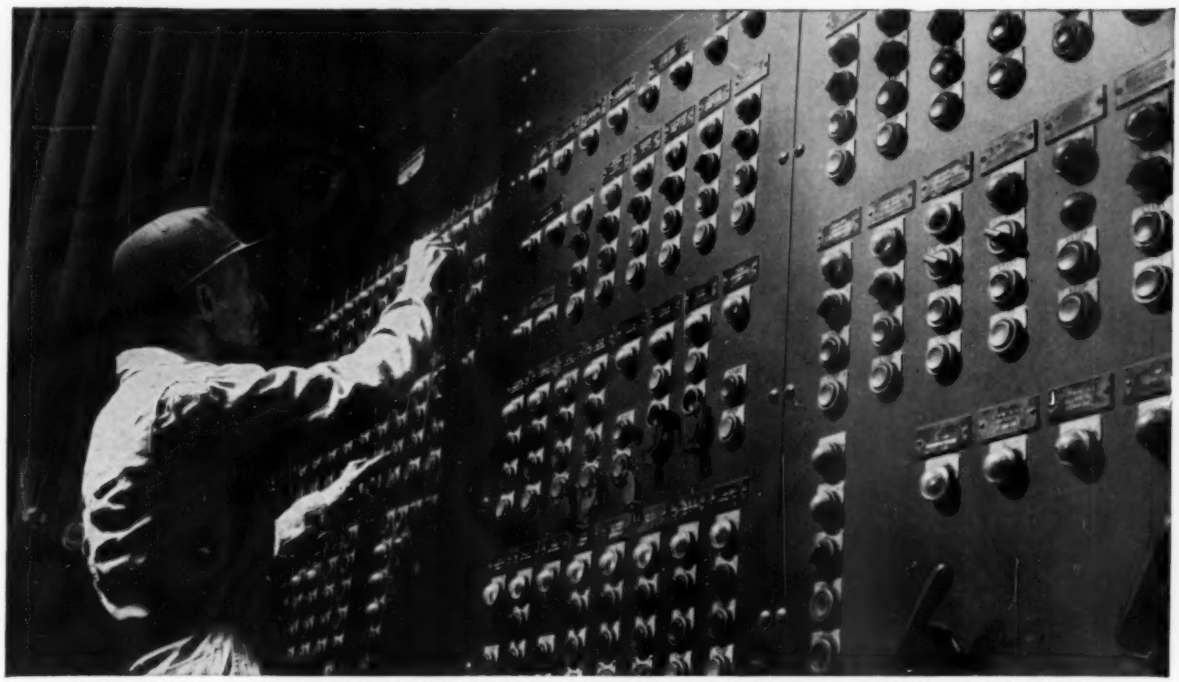

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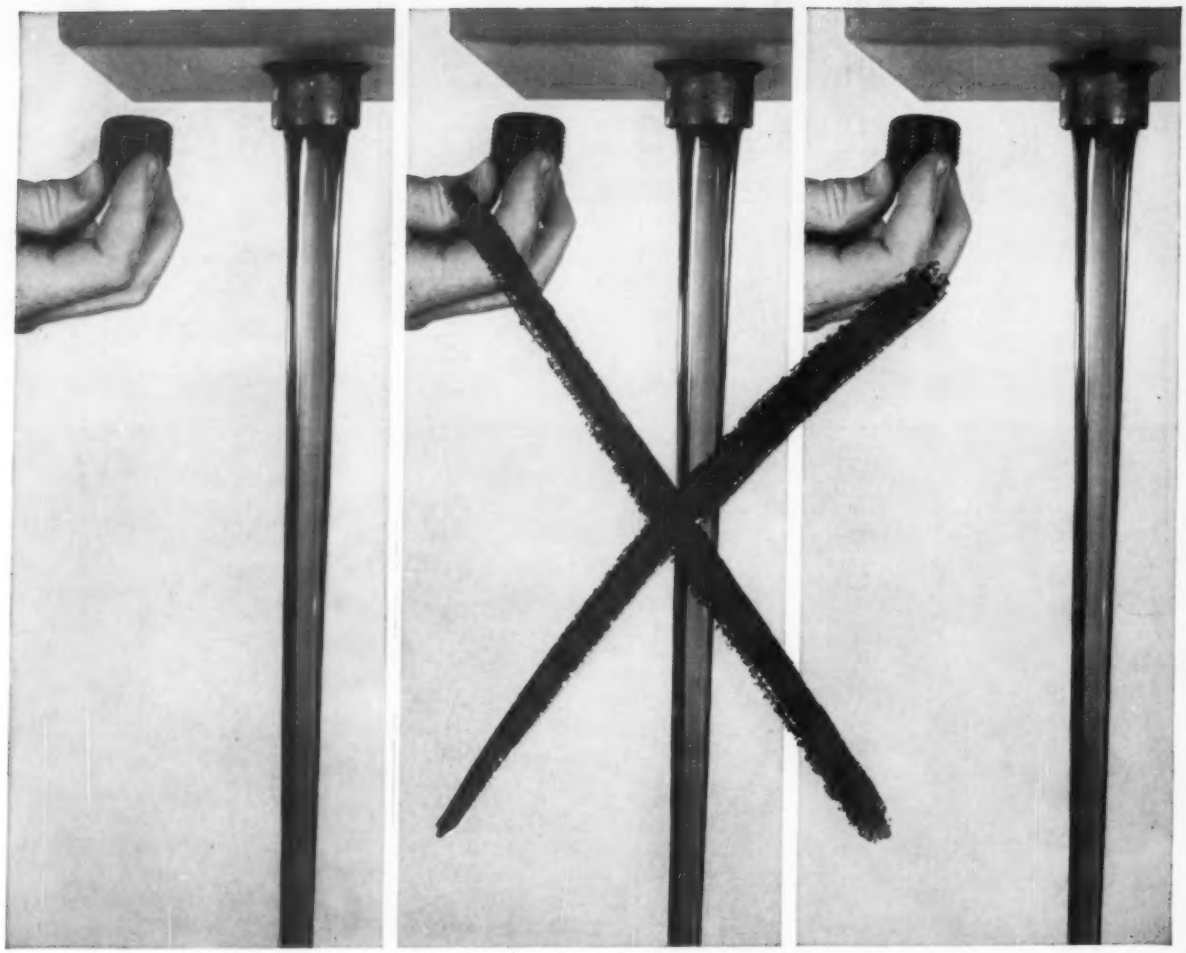

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